ECONOMIC GEOGRAPHY

VOL. 8 APRIL, 1932 No. 2

AGRICULTURAL REGIONS OF ASIA

PART II—THE NEAR EAST

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THE westward extension of Asia, lying south of the high mountain ranges extending westward from the Hindu Kush to the Caucasus Mountains and west of the Sulaiman Range, constitutes a distinctive region in which the climate is essentially Mediterranean with a definite winter maximum. The high mountain ranges rise like walls from the Indus Valley on the east and the Aral-Caspian lowlands on the north. The region is connected with Asia Proper by the mountain-crested plateau of Kafiristan in northeastern Afghanistan, and despite local differences in the region, mainly physiographic, it can best be treated as a distinct unit.

Climatically it is also relatively unified, for with the exception of the extreme southwestern corner of Arabia and the Kabul Valley of Afghanistan, Mediterranean elements characterize the climate. Though the rainfall is light in some places and rather heavy in other places, the maximum, or in some places all the rainfall, comes in winter, and thus the region may be considered a major climatic division, bordered on the east by the monsoon climate of India, and on the north by the continental climate of Russian Turkestan with its tendency toward summer rain. Whether desert plateau, or well-watered mountain slope, the several divisions of the region constitute an integral whole with similar physical features and similar rainfall régime.

The distinctive factors of relief and climate within the limits of these major similar elements constitute the criteria by which the several subregions of land utilization and agriculture may be discriminated; indeed, the information regarding soils and crop acreage are so inadequate and untrustworthy that they cannot be used anywhere in the region for classification or map purposes.

As indicated in the earlier instalment, three major physiographic divisions are recognized: the Alpine Mountain system; the Arabian Block; and the synclinal lowland between them. The Alpine Mountain system may be subdivided into three sections, two of them—the basin of Asia Minor (Anatolia) and the basin of Iran—widened intermontane basins enclosed by encompassing mountains constituting the prevalent double-range formation; and one of them, Armenia, a complex mountain upland at the juncture of the Anatolian and Iran Mountain systems. A fourth subdivision may be considered, the Caucasus, which forms a structural threshold to the main

Alpine system, separated from the Armenian complex by the Transcaucasian trough.

The Arabian Block, with its tendency toward uplifted edges and its central mountain axes, might well be treated as a unit, did not the historical importance of its northwestern edge—the Syrian-Judean anticlinal uplift with its enclosed rift valley—necessitated a more detailed discussion of that significant section.

The synclinal lowland between the Alpine system and the Arabian Block, includes only the Mesopotamian depression, part of which is occupied by the invasion of a branch of the Indian Ocean, the Persian Gulf.

The following references are recommended as useful in a general treatment of the Near East:

Asie Occidental by Raoul Blanchard—a masterpiece of description, unrivalled as a modern interpretation.

Asia by L. Dudley Stamp—pages 65–165—a well-written regional treatment.

Die Türkei by Ewald Banse—a pre-war treatise of the former Turkish Empire but invaluable for its enormous wealth of detailed observation.

Der Orient by Richard Uhden, from "Geographie des Welthandels."

Vorder Asien und Kaukasien by Hugo Grothe, from E. Von Seydlitzsches "Geography."

Die Mittelmeerlander by A. Philipson, which, though old, was written by a man with wide personal acquaintance with Mediterranean lands, especially of Asia Minor.

Mittelmeerbilder by Eugen Fisher—also old but vividly written from the cultural point of view.

Der Orient und die Orientalische Kultur by Alfred Hettner—"Geographische Zeitschrift," 1931.

ASIA MINOR (ANATOLIA)

The accompanying map of the distinctive regional sections of Asia Minor reflects the physiographic and geologic structure. The regions are as follows:

1. The narrow coastal zones along the southern and northern coasts, in places wholly absent.
2. The northern (Pontus) and southern (Taurus) mountain systems.
3. Inner Anatolia.
4. West Anatolia, the piedmont transition from the interior plateau and ridges toward the coastal foreland along Aegean Sea.

These regions correspond rather closely with those given by G. P. Merriam, "The Regional Geography of Anatolia," ECONOMIC GEOGRAPHY, Volume II, No. 1, January, 1926, but they are designated by general terms instead of agricultural terms or land utilization names to conform with the treatment of the other regions of the Near East and to constitute a general geographic classification rather than specialized agricultural divisions.

THE NORTHERN COASTAL ZONE

The narrow northern coastal zone along the Black Sea is of significant agricultural importance. It is widest in the east; in the west it disappears entirely where the mountains in places rise precipitously in cliffs out of the waters of the Black Sea. Strong, northerly winds blow the year round—in winter toward the

Mediterranean low and in summer toward the heated interior—and cause heavy rain rather well distributed throughout the year although with a summer minimum, and heaviest eastward. The climate is distinctively marine Mediterranean, but in the west, where the chill winds direct from the frozen Russian plains sweep unhampered southward across the Black Sea onto the coast, the winters are relatively cold, though somewhat tempered by the open waters of the sea. Eastward the high Caucasus Ranges protect the section from farming populace after the Greco-Turkish War prove a severe handicap to further development.

THE PONTUS MOUNTAINS

Rising abruptly from the narrow coastal plains like a steep wall, broken only at a few places by canyon-like river valleys, the Pontus Mountains stand mantled by a luxuriant forest vegetation consequent upon the heavy rainfall. It constitutes a forest of oak, chestnut, beech, elm, fir, and pine, exceedingly dense in the eastern section where

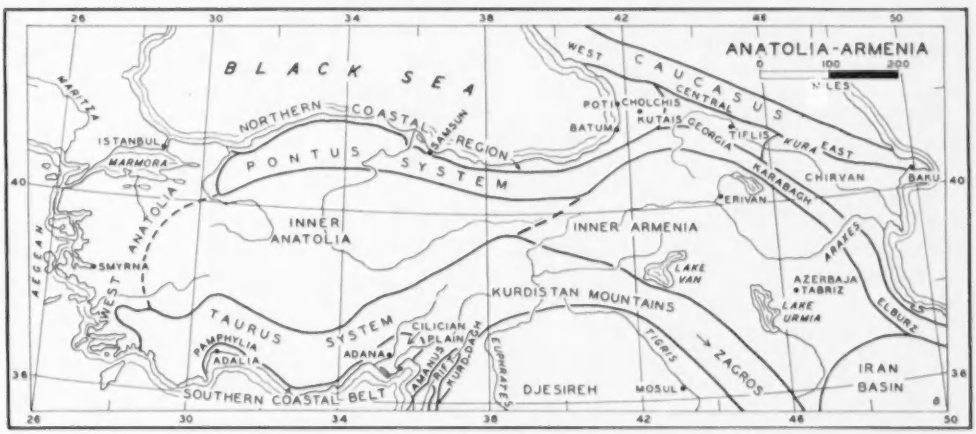

FIGURE 1.—Anatolia, Armenia, and Transcaucasia constitute a rather definite geographic unit, which may be effectively subdivided on the basis of differences in the physical elements of the terrane.

the cold northerlies. Fertile alluvial soils, most extensive on the deltas of the rivers; the high rainfall; and fairly equable temperature promote intensive use of the land. Wheat primarily, and maize secondarily, are the most important cereal crops. Mediterranean fruits are grown nearly everywhere, but olives are missing from the colder, western portion. Eastward, tobacco assumes more than local importance, particularly in the environs of Samsun, the chief shipping port. Hence, the population is dense; but limited area, and the deportation of the Greek

the elevations are higher, the precipitation greater, and the winters milder, but more open, with an undergrowth of rhododendron brush, in the drier and colder western portion. In the wind shadow on the southern slope of the mountains the rainfall decreases significantly, and grasslands favorable for stock raising take the place of the forests, with crop agriculture limited to dry farming, or to irrigation in the river valleys and depressions. Ernest Nowack ("Journeys in Northern Anatolia," *Geographical Review*, Volume 21, No. 1, January, 1931) distin-

FIGURE 2.—Pastoralism has ever been the dominant form of land utilization on the steppe sections of Anatolia, and transhumance has for centuries characterized most of the regions discussed in this instalment of the "Agricultural Regions of Asia." (Courtesy of Ginn and Co.)

guishes this piedmontal zone of transition from the drier steppe regions of Inner Anatolia.

THE SOUTHERN COASTAL BELT

The Taurus Mountains leave only two limited coastal plains with sufficient space for the cultivation of land and rural settlement along the southern shore of Asia Minor: the flat, coastal plain of Pamphylia (Adalia) and the similar plain of Cilicia (Adana). Both are rimmed by hills and mountains from which turbulent streams bring sufficient water for irrigation, permitting the growth of rich crops of cereals and subtropical fruits upon the fertile, alluvial soil; both have in common long, dry, hot summers, so warm that the local winds from the sea into the heated interior are not chilled, as they rise up onto the plateau, enough to cause precipitation, and both regions are exposed to the danger of fevers and malaria produced by insect pests from the coastal marshes. Of the two plains, Cilicia, the more important, is often compared with Egypt because of its similar climate and its annual floods of the rivers from the Taurus and the Anti-Taurus Mountains. The heavy winter precipitation of these mountains is mostly in the form of snow, which in melting is augmented by rains which cause heavy freshets. Cilicia also resembles Egypt in the importance of its two industrial crops—sugar cane and cotton. Though the quality of the Cilician cotton does not approach that of the Egyptian, it constitutes an important export commodity, constituting the major portion of the two hundred thousand bales or so which have recently formed the Turkish cotton crop. Both these southern plains evince strong evidence of political, economic, and social neglect, for they could be made many times as productive as they are now.

THE TAURUS MOUNTAINS

The Taurus Mountains, higher and wilder than the Pontus Ranges, and separating more effectively narrow coast and broad interior, rise steeply from the Mediterranean, leaving space for coastal plain only in small scattered tracts. Their heavy precipitation is almost wholly confined to the winter season when a thick cover of snow mantles the slopes and crests; in summer when the winds blow chiefly from the north toward the deep, low-pressure area on the Indus, only the highest peaks and crests are moistened by the air from the Mediterranean drawn through major mountain gaps up onto the heated interior. Where not felled, forests cover the mountain slopes: typical Mediterranean machi up to 2,000 feet, colorful and fragrant, when the winter rains bring it into bloom, but dull and dreary in summer; higher a belt of distinctive deciduous forest, chiefly oak; and beyond this up to the tree-line, conifers. Some timber is cut on these mountains and shipped from some of the coastal harbors.

INNER ANATOLIA

Inner Anatolia does not constitute a true basin. Though in places somewhat mountainous, it consists primarily of a plateau surrounded by steep and high mountains which keep out the marine influence on the climate of the surrounding Mediterranean. Consequently, the winters are continentally cold with most of the precipitation in the form of snow and aggregating only about ten inches of precipitation for the year, for the summers are hot and dry. The Anatolian steppes, set with blossoms and green with luscious grass in early spring, become parched and burned under the glaring summer sun. Only a few of the rivers which rise on the more humid higher slopes maintain themselves across the steppe to escape through the mountain wall to the north coast. The others lose themselves in reedy, shallow lakes which occasionally become typical playas in the dry season.

FIGURE 3.—Transportation in Anatolia, like agriculture and other industries, is by primitive methods. Lack of accumulated capital for the purchase of modern equipment keeps everything centuries behind the times. (Courtesy of Carl Stotz.)

The summer dry steppes of Inner Anatolia form the home and grazing grounds of the Anatolian nomads with their herds of cattle, sheep, and goats. The sheep—Turkey has ten million—provide wool, milk, and meat. *Yogurt* (*Yohourt*), sour sheep milk, popularized in Europe by the Bulgarians, and in America as bulgarlac, is the *pièce-de-resistance* of the Anatolian peasant diet. Mutton and lamb are transported as far as the western Turkish cities, where it forms the main supply of meat. Wool is the most important material for clothing and is also used as the basis of the carpet and rug industry, which flourished prosperously until the Greeks were forced to leave Asia

Minor. The well-known Angora goats furnish meat and milk, but more significantly the famous mohair.

Along the rivers where irrigation is possible, or on the mountain slopes where rain is adequate for agriculture, wheat becomes an important crop and, according to Dudley Stamp, 15,000 tons of wheat are shipped from the Konia railway station alone to supply a considerable proportion of the needs of Istanbul. The wheat fields and other crop lands of Inner Anatolia stand out in sharp contrast to the pastoral steppes where the herds of sheep and goats wander in search of food in summer and of shelter, as well as sustenance, in winter.

FIGURE 4.—Wood, wherever it is available for fuel, constitutes an important item of local trade, brought in to the villages from the wooded rural districts, usually the higher mountain slopes, by the most primitive wheeled carts. (Courtesy of Carl Stotz.)

WEST ANATOLIA

West Anatolia does not lend itself satisfactorily to treatment as a unified geographic region because of its physical complexity. Northward and southward, the westward extensions of the Pontus and Taurus Ranges may be recognized, between which the east-west trending structural ranges indicate their relation to the mountain systems of Greece, from which they are separated by the Aegean. They constitute a drowned coastline, with promontories and rocky islands, from which uplifted mountains and structural depressions extend confusedly inland.

The climate is typically Mediterranean with mild, rainy winters and hot, dry summers. The precipitation is about thirty inches, least southward. Northward the influence of the cold, northerly winds in winter is felt to the south shore of the Sea of Marmora. The distribution and character of vegetation conform to the distribution and type of rainfall and temperature. The Pontic type of forest continues toward Istanbul and along the southern shore of the Sea of Marmora, a zone of forest exploitation, in the northern part of the section. In the southern section, Mediterranean sclerophyllous scrub, characterized by the machi, replaces the dense forest vegetation of the northern section.

The agricultural significance of West Anatolia is comprised in its cultivated valleys and lowlands with their wealth of fruit gardens and crop lands. Wheat, barley, and corn suffice for local needs; cotton, tobacco, and opium fields vary the landscape and yield exportable surplus. Fruits, as elsewhere in the Mediterranean, are typical. Except where the cold winter winds sweep the northern section, olive trees cover the slopes along the shore and mantle the valleys and basins. Sultana grapes are dried and exported from Smyrna (now called Izmir). Between 20,000 and 40,000 tons are annually exported from the Meander River valley.

West Anatolia is absolutely the

most important agricultural region of the Near East. Its crops of cereals, cotton, tobacco, and Mediterranean fruits; the pastoral products of the steppes and deforested mountains; and the products of its forests still remaining on the mountains in the north and the south, such as the tannin from the Valonia oak and the timber as well; all these combine to make the region almost self-contained and well balanced in its agricultural industry, both from the local viewpoint and from the foreign trade point of view. Economically, the exile of the industrious and agrarian Greek population so seriously handicapped the agriculture of the region that it has been at a tremendous disadvantage ever since, despite the influx of Turks from Macedonia and Thrace.

ARMENIA

Armenia may be divided into two mountain systems and Inner Armenia bounded by the mountains which rise to a height of 10,000 feet. The southern boundary is formed by the Kurdistan Mountains, a continuation of the Taurus system of Asia Minor. Broken only by the deep gorge of the Euphrates, they form a formidable wall separating the Inner Armenian uplands from northern Mesopotamia. Along their slopes westward, the rainfall continues adequate to sustain a forest cover of oaks dominantly on the lower slopes with junipers and hawthorns higher; eastward, grassland almost monopolizes the region, for, throughout, the summers are hot and dry. This is a region of pronounced transhumance, a regular seasonal migration of the nomadic population from the croplands at the foot of the mountains where in winter there is opportunity for a limited sedentary crop agriculture, to the upland meadows as soon as the spring harvest is over, the herds of cattle, sheep, and goats being driven to the grasslands where they find sufficient pasturage until the fall snows and inclement weather. Water for irrigation is available in the deeply graved valleys, and grains and fruits are grown on the terraced slopes.

FIGURE 5.—The camel caravan characterizes the highways of Turkey. Bearing wheat from the crop-growing plateaus to Seljonk in the valley of the Meander River, this camel train illustrates how old-fashioned and economically defective are the means of transportation throughout the Near East, except along the few strands of the railway net. (Courtesy of Carl Stotz.)

The northern mountain border is less distinct. The northern Armenian Mountains, the eastward continuation of the Pontic system of Anatolia, exhibit gradational transition from the humid mountain climate in the west to the drought of eastern Transcaucasia, and from the western dense forest with its undergrowth of rhododendron and azalea to open grassy coniferous parkland. The nutritious grasses of these upland

pastures form the chief economic asset of the northern Armenian Mountains, especially in the eastern Karabagh, for upon them are sustained the pastoral herds of the nomadic tribes in summer when the surrounding lower lands are seared and bleached.

INNER ARMENIA

Inner Armenia displays exceeding complexity of relief. Relatively much lower than the surrounding mountains, it combines serrated mountain ranges with cradle-like valleys; high plateaus with wide basins, in many places lake-filled; and volcanoes of which Mount Ararat, 17,000 feet high, is the best known, with rolling piedmonts. It constitutes the cordilleran knot, where the Anatolian and Persian Mountain axes converge. On its highland plains, characterized by steppe and forest-steppe vegetation, stock raising is important and cereal crops, like wheat, rye, and barley, may be grown in spring after the winter rain season, and harvested in early summer. In its deep depressions where water is available, as in the upper valley of the Araxes about Erivan and along the shores of Lake Van and Lake Urmia, cotton and rice are produced and an abundance and variety of fruit.

In the Persian province of Azerbaijan, of which Lake Urmia is the economic center, the bare mountains betray the approaching aridity of the Iran Basin; but the high slopes of the volcanoes surrounding Tabriz collect enough moisture to provide pasture for the herds and irrigation for the crops of the surrounding plains.

FIGURE 6.—The housing, like everything else, is primitive; where field stone is not available, the Turkish farmer builds his hut of mud mixed with dung, and thatches it with straw. (Courtesy of Carl Stotz.)

TRANSCAUCASIA

Transcaucasia is that area lying beyond the Caucasus Mountains southward from Russia. The Caucasus Mountains stand like a barrier wall between the steppes of European Russia and the valleys beyond. They suggest the Pyrennees between France and Spain in their barrier character; they extend from sea to sea, they bar transportation, they form a refuge for the population in times of war, and they constitute a transition from a wet to a dry climate—in all these respects, the Cau-

casus are like the Pyrennees. They are unlike the Pyrennees because they ward off the cold winter winds of the frozen Russian plains from the subtropical lands beyond, as the Pyrennees do not bar any such wind across from France to Spain.

The West Caucasus, like the west Pontic Ranges, receive copious rainfall, and rise steeply out of the Black Sea without any coastal plain as the threshold. The slopes are heavily forested and glaciers cover all the higher peaks and ridges. The Central Caucasus receive much less precipitation, but their high elevation (Mount Elbruz, 19,000 feet) produces a continuous glacial mantle. The slopes are forested, but park land and occasional stretches of grassland are interspersed on gentler slopes and plateaus. The East Caucasus more nearly resemble a plateau than a mountain range. They exhibit the dry barrenness of the mountains of central Asia, with steppes replacing the forests and alpine meadows of the Western and Central Caucasus.

Transcaucasia, which occupies the synclinal trough between the Caucasus and the northern Armenian Mountains may be divided into three sections: Cholchis, Georgia, and Chirvan.

CHOLCHIS

This western section of Transcaucasia is characterized by heavy rainfall distributed fairly evenly throughout the year. Dense forests mantle the hills and mountain slopes and the marshy coastal plain is almost devoid of people except where the more fertile areas have been drained or seaports established, as, for instance, at Batum and Poti. Inland toward Kutais and in the lower valleys of the Central Caucasus, the mild climate and ample rainfall are favorable for the growth of wheat on the drier lands and maize on the moister, for the cultivation of early vegetables and Mediterranean fruits, and on the red soils of the hills about Chokva for the intensive culture of tea, partially to supply the

FIGURE 7.—The houses of the towns and villages differ from those of the country only in their shingled or tiled roofs. Eskishere illustrates the adobe houses built of mud and dung. (Courtesy of Carl Stotz.)

FIGURE 8.—An example of the antiquated agricultural technic of Asia Minor, as seen near Denizili in the valley of the Meander. The winnowing of the wheat is as primitive as the threshing. (Courtesy of Carl Stotz.)

heavy demand for that beverage in the great Soviet market.

GEORGIA

Georgia, the middle portion of Transcaucasia, is neither so wet as Cholchis, nor so dry as Chirvan. The forest disappears quickly eastward from the divide between the Black and Caspian Seas, and along the upper courses of the Kura River it gives way to thorny scrubland and shrub-studded steppe, a region of exceedingly hot and dry summers, with occasional destructive cloudbursts from the mountains due to excessive convection. On the steppes about Tiflis, irrigation water supplied by the streams which issue from the mountains permits the cultivation of cereals, tobacco, rice, and a great variety of fruits, particularly watermelons and muskmelons.

CHIRVAN

Chirvan, the most easterly section of Transcaucasia, displays an almost desert-like character with distinctive desert fauna and type of vegetation. The plains of the Kura and Araxes are dry steppes seered brown and lifeless in summer. Piedmontal oases gleam green along the foot of the mountains, where rivers fed by the snows and ice of the higher peaks debouch upon their alluvial fans and cones that fringe the valley. Limited tracts of irrigated land grow grains, indifferent cotton, and fruit, particularly melons.

IRAN

Iran, the third subdivision of the Alpine section of the Near East, is completely bordered by great mountain ranges. The physiographic regions may be readily distinguished except in the eastern interior where, south of the longitudinal valleys of the Hari-Rud and the Kabul, the mountains extend southwestward as the Hazara. The vast interior basin enclosed by these great mountain ranges may be subdivided into Persia Proper and the lake basins of Seistan and Inner Baluchistan.

THE NORTHERN MOUNTAINS

The Elburz Mountains constitute the barrier wall between the Persian interior and the narrow Caspian coast. Above them towers the great volcanic cone of Mt. Demavend, which gives rise to a whole series of mountain streams that lose themselves in the alluvial mantle along the edges of the desert. On the north slope of these high mountains the rainfall is copious and rather evenly distributed throughout the year. The prevailing wind direction upon this slope is from the north across the Caspian Sea. Luxuriant forests grace the gullied mountain slopes on this northern side of the great range, in striking contrast to the desiccated, barren, rock-

strewn, southern flank of the range, a contrast that has elicited notice by all travelers who have passed from the desolate plains with their cloudless skies on the south slopes to the verdant, wooded ridges of the north side, moistened by mist and dew. The narrow coastal plain between the Elburz and the Caspian is fertile and productive, but unhealthful because of the fevers which originate in its change. The mountains of Khorassan widen, and becoming lower, cease to be such a difficult barrier; a branch continues northeastward and encircles the basin about the lower courses of the Atrek River, which flows between two relatively low ranges. As elsewhere in the Near East, the precipitation decreases toward the east. Forests become more open and rise higher on the slopes of the ranges.

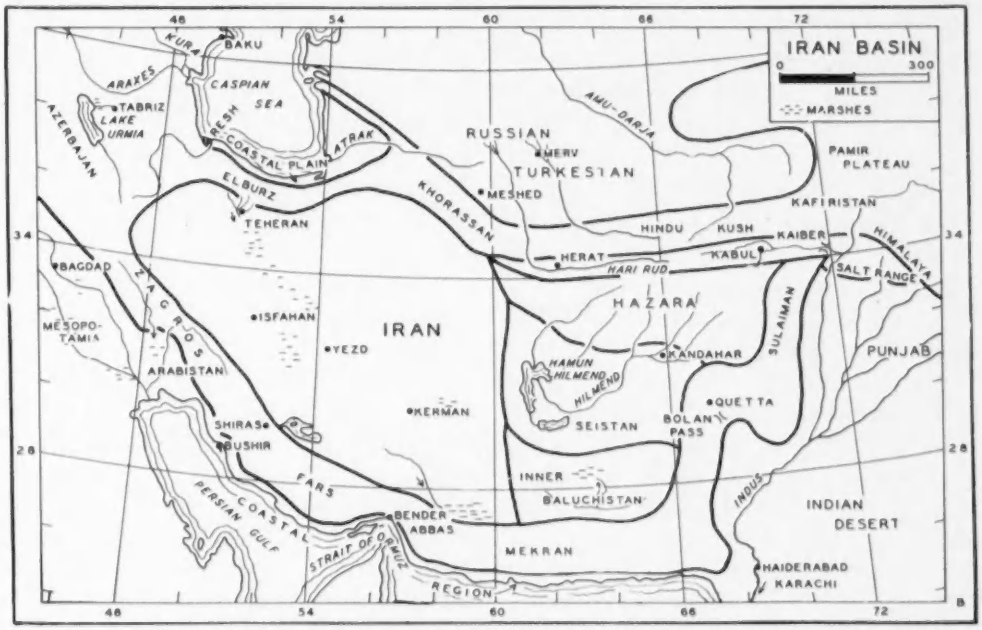

FIGURE 9.—The Iran Basin forms another distinctive division of the Near East region of Asia in which the climate is essentially of Mediterranean type. Near the eastern border of the region the monsoon begins to exert its influence, and on the northern border, the continental climate of Turkestan encroaches.

flooded, lacustrine marshes, where mosquitoes innumerable breed. Despite occasional destructive cold waves, the climate is relatively warm and moist, favorable to such semitropical crops as rice and sugar cane as well as toward Mediterranean cereals and fruits, tobacco, and mulberry for sericulture. The dense population of this coastal belt is impressive by contrast with the sparse peopling of the rest of the region.

East from the Caspian, conditions The valleys and basins between the ranges are densely populated, the irrigation water of the mountain streams permitting the growth of heavy crops of wheat and barley and an abundance of fruit for many people. Meshed is the popular center of this area.

The Khorassan Ranges east of the gap of the Hari Rud are much drier than those west, and the arboreal growth is replaced by scrub vegetation and grass. The precipitation

on the high elevations continues sufficient for the irrigation of the great longitudinal valley of the Hari Rud, where the landscape is distinguished for a hundred and fifty miles by avenues of towering poplars along the streams and irrigation ditches which water the fields of grain and the gardens of fruit.

The Hindu Kush with Kafiristan, its eastern continuation connecting with the Pamir Plateau, constitute the first example of an increasing precipitation toward the east, the result of the Indian summer monsoon. The Kabul Valley system, though separated by a high divide from the valley of the Hari Rud, is combined with the Hari Rud Valley as one regional belt in order to stress the agricultural value of these longitudinal valleys. The Kabul Valley receives augmented precipitation from the summer monsoon, and produces heavy crops of grain throughout and typically Indian crops like sugar cane toward the east where the valley floor lies lowest. This section does not really belong to the Near East, but rather to the monsoon region of India, even though it is included with the Hari Rud region in order to emphasize the agricultural relationship of these longitudinal valleys.

THE SOUTHERN AND EASTERN BORDER

The Zagros Mountains form a system which is a continuation of the Kurdistan Mountains. High ranges, enclosing longitudinal valleys, reveal rather regular folding. With increasing distance from the Mediterranean, the precipitation decreases southeastward. High mountain pastures, deep in snow in winter, form the upper limit of land utilization, and forests, of which, as in Kurdistan, the oak is the typical tree, flank the slopes below the mountain pastures. Transhumance has been followed here for thousands of years, the pastoral peoples of the region bringing their stock to the highland grasslands in summer and taking it back again to the neighboring plains in winter, where the climate is mild and open. In the valleys and intermontane plains, particularly where water for irrigation is available, agriculture is successfully carried on, the type of crop depending upon the elevation. As in the European Alps, the peasants devote part of their time in the growing season to their crops in the valleys and part to their stock in the highland pastures.

Southeastward, aridity and drought become the decisive and dominating factors in the land utilization and agriculture. The dry Fars succeeds the humid Zagros. The coastal plain along the Persian Gulf is torrid. Along much of the coast, only occasional heavy dews provide any moisture. Life and industry are concentrated in a few oases, like Bushir and Bender Abbas, where dates grow abundantly. The mountain walls which abut upon this coastal plain are almost as arid as the plain itself; no forest adorns their flanks or crests, though on the higher elevations some grazing is possible and, in a few favored spots, limpid springs, fed by the melting winter snows, water fertile oases like Shiras.

East of the Strait of Ormuz the Mekran Mountains of Baluchistan are similarly arid. Fishing in the offshore waters is the chief source of income for the few inhabitants who dwell in the scattered date palm oases. The barren mountains, with an annual precipitation of from only three to six inches, locally provide sparse pasturage for the herds of the

nomads, who spend their winters on the alluvial plains. Wheat, millet, and a little fruit are grown where subterranean channels of percolating water moisten the soil in a very few favorable spots.

The famous Bolan Pass, the entrance to southern Afghanistan, guarded by the town of Quetta at the gateway southeastward, is succeeded by the Sulaiman Ranges which close the Iran on the east, and merge with the ranges of the Hindu Kush northeastward. Brown, barren slopes indicate the extreme aridity, and only a very few green patches on the higher ridges and crests reveal the spots where fog and rain sometimes dampen the ground. Toward the Kaiber Pass the influence of the summer monsoon makes itself felt in increased precipitation, and fields and orchards reappear in ever-increasing numbers in the landscape of all the irrigated valleys.

THE INTERIOR

Encompassed by formidable mountains, the interior resembles the basin of central Asia. Cold, dry winters, typical of interior highlands, alternate with equally typical hot, dry summers (Teheran averages 85 degrees F. during July). Heavy winds, mainly from the northeast, stir up clouds of dust and add to the discomfort of almost every day. Three types of land use may be distinguished: the interbasin mountains; the fringing oases; and the intermontane basins.

The Mountains

Though the mountains appear bare and unproductive, a little rain falls every winter on the higher slopes and provides some grazing for the herds of the nomadic tribes. The search for grass is the continual and eternal activity for the herdsmen, whose sheep and goats must be fed.

The Oases

Along the foot of the encompassing mountains, and of the interbasin ranges as well, lie belts of scattered oases where water from the mountains succeeds in reaching the borders of the plain. Ingenius underground channels, the "Kanats"[1] carry the water from the mountain streams to the flanking terraces and level areas of suitable soil. Crops vary with latitude; temperate grains are grown in the northern sections; rice, corn, and dates are cultivated in the southern sections. Tobacco and opium are produced chiefly for local consumption. Dudley Stamp states that under Persian law, any one who brings barren land under cultivation becomes legal owner of it. The farming population of Persia works mainly as village units, and the three-field system is widely prevalent. Isfahan is the largest oases center in the section north of the Zagros. Teheran,[2] the capital of Persia, is supported by the long fringe of oases bordering the southern slopes of the Elburz and western Khorassan. Kandahar borders the Khorassan Mountains, and Yezd and Kerman are examples of oases supported by moisture from the interbasin ranges.

The Intermontane Basins[3]

The intermontane basins are true deserts because except for a few rare

[1] Fisher, Commodore B. "Irrigation Systems in Persia." *Geog. Rev.*, Vol. 8, No. 2, April, 1928.

[2] Clapp, Frederick G. "Teheran and the Elburz." *Geog. Rev.*, Vol. 20, No. 1, Jan., 1930.

[3] Huntington, Ellsworth. "The Basins of Eastern Persia and Seistan." Carnegie Institution of Washington. Publication No. 26. Washington, 1905.

convectional showers, they never receive any rain. Filled with mud and gravel poured out by the occasional turbulent floods from the surrounding mountains, they are often saturated with alkaline waters after a convectional cloudburst has drenched the surrounding mountains; and in many places, they hold salt lakes or swamps, which vary widely in extent with the frequency and character of the montane storms.

Of all these basins only Seistan demands special attention. The Seistan Basin is fairly well watered by the numerous branches of the Hilmend River which issue from the Hazara Mountains and debouch upon the Basin. These tributaries converge upon Hamun, a fresh-water lake, kept fresh according to Blanchard, because every winter when the lake bed is almost totally dry, the strong winds that prevail blow the accumulated salts away. The fragments of the lake which remain sustain abundant fish to spread throughout the extent of the lake at its maximum. The delta of the Hilmend, richly productive, forms a distinctive contrast to the desert environment in which it is set like a jewel. Along the courses of the various branches of the river, irrigation is nearly everywhere possible and practiced, so that the river is bordered by belts of luxuriant verdure, chiefly tamarisk, exquisitely beautiful in full pink bloom. Fruit trees cannot grow on the irrigated delta because of the tempestuous winds, but cereals do well and the population is dense.

MESOPOTAMIA

Mesopotamia comprises parts of three physiographic regions: The northern, where alpine ranges parallel to the Kurdistan Mountains, dominate the relief; the central, where the Arabian Block is the basic element in the relief; and the southern, a structural trough, filled with alluvial material, which is pushing itself farther and farther into the Persian Gulf.

NORTHERN MESOPOTAMIA

Permitted by the lower elevation of the Aleppo region to penetrate inland, the Mediterranean winter rains sweep along the foot of the Kurdistan Mountains, to supply enough moisture to the plains and basins between the dry limestone ridges for crops of grain, principally wheat and barley, and fruits; where water for irrigation is available, walled fruit gardens surround the settlements of the agricultural regions, and vineyards of luscious grapes enrich the dietary of the peasants. Fertile volcanic soil and moderate water supply combine to make the plain of Diarbekr a great wheat-producing region.

CENTRAL MESOPOTAMIA

The central section, or Djesireh, resembles the steppes of eastern Syria and northern Arabia. Nomadism dominates the agricultural use of the land, and very few sedentary farmers may be found in the region. Only along the Euphrates and the Tigris, with its eastern tributaries, is agriculture possible and only by irrigation. On the whole it is a poor and infertile country, but many evidences of former productivity and prosperity beyond the limits of the present agricultural area indicate that the water of these streams could be much more advantageously utilized.

SOUTHERN MESOPOTAMIA

The plateau passes by a noticeable escarpment to the delta plain of the confluence of the Euphrates and Tigris. Although winter temperatures are relatively low, the summers are very hot, and the deficient rainfall of ten inches, practically all of which falls in winter, makes the region a sparse steppe where scattered nomads graze their herds, except where irrigation permits farming. Stable government would insure efficient use of the copious spring floods, when the Euphrates rises twelve feet and the Tigris twenty feet above the winter level, and make of lower Mesopotamia one of the world's most productive regions, comparable to the Nile plain of Egypt; but many difficulties must be overcome. One of the most discouraging is the great amount of silt carried by the streams, which deposit their load when they reach the lower gradients of the

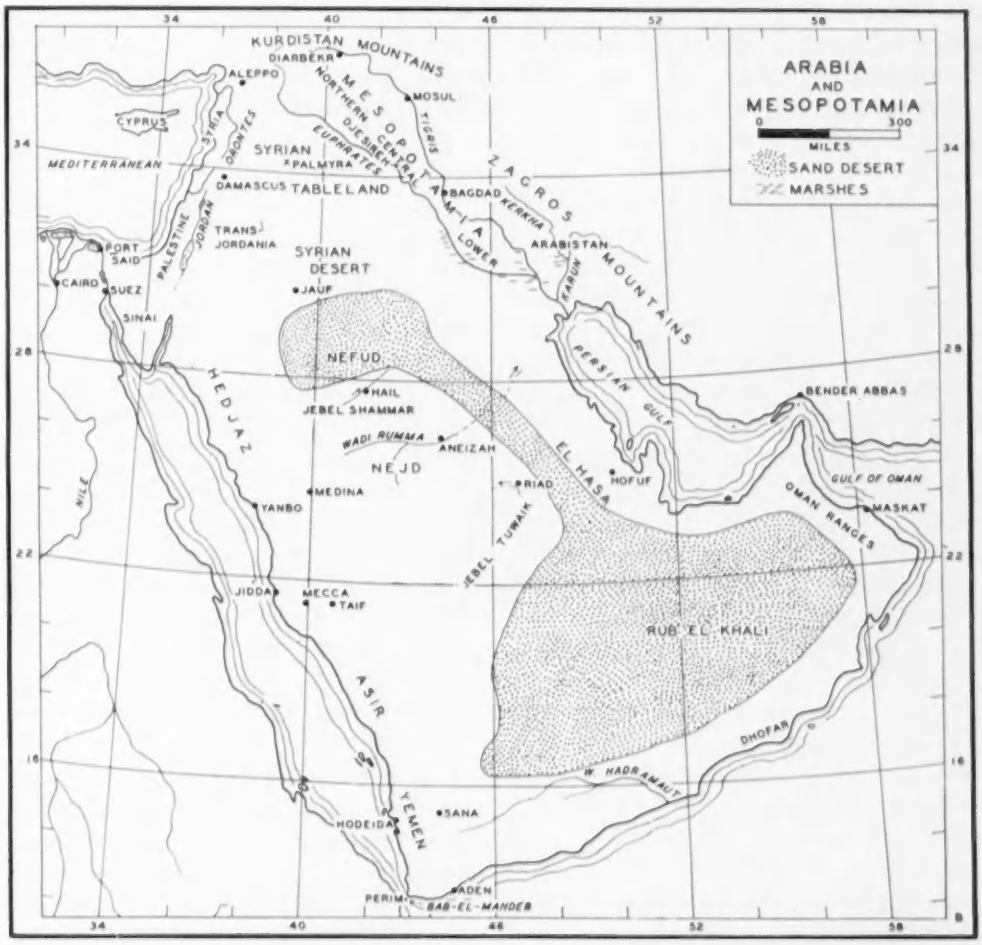

FIGURE 10.—The massive Arabian Block and the Mesopotamian Basin constitute regions related to, and part of, the Near East Mediterranean terrane, extensive and varied, but only in a few isolated sections like Yemen and Oman, departing significantly from the characteristic Mediterranean régime of summer drought and winter precipitation.

plain and choke the irrigation canals and trenches. Other difficulties, almost as important, add to the cost of reclamation, such as the necessity for great reservoirs to store the water for use in the dry growing season and for embankments and dikes to protect the lowlands from the flood waters, which stagnate upon the plains in unhealthful malarial marshes that become salt deserts in the height of summer. The present great reclamation projects under operation, a tribute to the engineering skill of Sir William Wilcox, are only an earnest of what may be accomplished with sufficient funds and enterprise. Even under the present inadequate utilization, the Mesopotamian plain is of great agricultural importance. Such winter crops as wheat and barley and summer crops like rice and cotton are grown on the irrigated lands. The greatest wealth of the region comes from the date plantations which extend continuously along the river courses. The export of dates in 1927–1928 was 153,000 tons and in 1928–1929, 114,000 tons. The cultivation of cotton is vigorously encouraged by the British Cotton Growing Association, but the crop, as yet, is still small, amounting to only 5,200 bales in 1928.

ARABISTAN

The alluvial plain of the Kerkha and Karun River systems in the Persian province, known as Arabistan, belongs to the Mesopotamian division. The hot summer and lack of rainfall during the growing season make the steppe a desert in summer, where only irrigation can make agricultural use of the land possible. One of the world's earliest civilizations (Elam) arose from a well-developed irrigation system in this region, but at the present time irrigation is not well developed, because adequate capital to build the necessary canals and other equipment is not available. The only possibility and hope for the future is that revenue from the exploitation of petroleum along the lower slopes of the Zagros Mountains may rejuvenate this once so productive and prosperous, but now so destitute and unhappy, region.

THE ARABIAN BLOCK

Omitting Syria-Palestine at the present for a more detailed description later, we can divide the Arabian Peninsula into four natural regions: the western border, the southern margin, the eastern edge, and the interior, which comprises the Nejd uplands in the middle and deserts to the north and south. The outstanding feature of human life and occupancy throughout this region is the search and struggle for water; nowhere except in the southwestern corner of summer rainfall is there precipitation enough to produce crops, except by irrigation water from neighboring high lands.

THE WESTERN BORDER

A hot, dry extreme desert region constitutes the narrow coastal zone along the western margin. The steep mountain wall, the edge of the plateau which faces upon this coastal desert, attains an elevation in some places of 10,000 feet. The deeply eroded slopes of that escarpment are utterly barren and unproductive, except on the highest elevations where there is some irregular winter precipitation absorbed and issued as a living spring to supply some verdant oasis like Medina or Taif. Taif produces the food for Mecca, the holy city of the Moslems, which stands in a des-

ert-like environment. The high elevation and consequent occasional low temperatures of these oases prohibit the growing of dates, but a great variety of Mediterranean fruits, such as grapes, peaches, apricots, and pomegranates can be grown. Wheat, barley, and many vegetables are successfully produced.

South of the Hedjaz the westernmost summer rain of Asia appears, and, though the region is arid and barren, the higher elevations receive an augmented rainfall, which furnishes water for a scrub vegetation on some of the slopes, and in some of the valleys along the base of the escarpment collects sufficiently to permit the cultivation of grain and the support of a rather dense population. Still farther south in the extreme southwestern corner of the Arabian Block, this summer rainfall increases so significantly that Yemen presents a radical contrast to the margin farther north. The coastal plains and the lower slopes, the so-called Tehama, of the escarpment in Yemen continue arid and desert-like with only a few oases settlements in the wadis or intermittent stream beds; the higher slopes, the so-called Serat, however, receive a relatively heavy summer rain, at times and in places exceeding forty inches, thus resembling the Abyssinian rainfall régime with which it corresponds.

Agriculture replaces pastoral nomadism; the terraced slopes produce crops of wheat, barley, and sorghums, and an abundance and variety of fruits, from dates in the lower sections to apples and plums in the higher regions; the carefully built terraces yield the famous Mocha coffee of which the culture has set the pattern for the later world-wide extension of coffee production.

FIGURE 11.—At times the Aden waterfont seems the hottest place in the world, but despite this handicap, it forms a busy place of trade and travel because of its location at one of the world's great crossroads. (Courtesy of Ginn and Co.)

Eastward from the highland margin, the rainfall decreases rapidly; though Sana, the capital of Yemen, is situated in the midst of cultivated crops at an elevation of 7,500 feet, the region immediately eastward is characterized by the grazing of sheep and camels, but the grass rapidly disappears to give way to barren desert.

THE SOUTHERN MARGIN

The narrow coastal zone of the southern margin, like that of the western border, is arid and desert-like, but like the highland slopes back of the western coastal belt, the high-

lands back of the southern coastal belt receive enough summer rain to provide water for irrigation in favorable spots and moisture enough for grass and herding on the mountain uplands. The oasis of Dhofar, at the foot of the mountain of the same name, constitutes one of the favorable, well-watered spots, where coconuts and dates grow luxuriantly. Another interesting oasis with distinctive land utilization lies along the sides of the Wadi Hadramaut in the edge of the plateau where water from the Yemen uplands sometimes fills the stream and provides ample flowing and ground water to support an intensive irrigation agriculture. Before the valley opens out upon the coastal plain, the supply of water and the verdant oases end.

THE EASTERN EDGE

The Arabian Block dips gradually toward the Persian Gulf. Conditions are everywhere desert-like except where a line of ground water springs issue to form the El Hasa fringe of oases of which Hofuf is the metropolis.

The Oman Ranges are geologically distinct from the Arabian Block in that they are folded outliers of the older Alpine tectonic movements. The mountains on the peninsula between the Persian Gulf and the Gulf of Oman rise abruptly from the sea with fjord-like characteristics. A coastal plain with a zone of oases lies between the Oman Mountains and the Gulf of Oman. This zone of oases constitutes the economic base of Oman agriculture and commerce, the main export product being dates. Some rain falls on the mountain and a little crop agriculture and considerable stock raising occupy the activities of the mountain groups. In the narrow fringe of oases in the southwestern part of Oman, springs issue from underground water systems to support crops and herding, facing upon the Rub'el Khali or great interior desert.

THE INTERIOR

The vast Rub'el Khali, probably the most extremely desert area of the world, is connected by a few sandy extensions with the Nefud northward. North of the end of the Nefud lies the oases of Jauf where ground water nourishes thousands of date palms that gleam like emeralds in contrast with the desert setting round about. Rub'el Khali and Nefud, with the connecting strips of sand, border on three sides Central Arabia, the massif of Nejd, where high elevations produce greater precipitation and permit considerable stock raising and herding, especially of camels as the principal means of sustenance. In winter the nomads pasture their herds on the upland steppes and in summer concentrate about the oases where water for the cattle, camels, and sheep is available. Riad is the best-known of the oases in this region for under its palm groves grow many vegetables and such fruits as grapes, figs, pomegranates, and apricots, and in the adjoining fields, wheat, barley, and lucerne to be used as fodders for the camels of the caravans which traverse the routes that converge upon this point. Other important oases are Hail at the foot of the mountains on the border of the Nefud, and Aneizah where the Wadi Rumma loses itself upon the desert sands.

LITERATURE ON ARABIA

Arabia has been explored chiefly by Englishmen; consequently, most

of the information regarding the region is published in the *Geographical Journal*. For northern Arabia, Alois Musil is the principal authority; for the central section, Philby; for the southern margin, Bent; and for Oman, Miles. More recent articles include the following:

Thomas, B. "The Southeastern Borderland of Rub'el Khali." *Geographical Journal*, 1929;

Cochrane, R. A. "Air Reconnaissance of the Hadhramaut" (with marvelous pictures). *Geographical Journal*, 1931;

Thomas, B. "Trip Through Rub'El Khali." *New York Times Magazine*, 1931, May 10–17, 24–31;

Musil, Alois. "Arabia Deserta," 1927.

Bury. George Wyman. "Arabia Infelix," 1915.

Thomas, B. "Arabia Felix," 1932.

and for Yemen, particularly,

Lamare, P. "L'Arabie heureuse." —l'Yemen, in *La Geographie*, 1924.

SYRIA-PALESTINE

The structure of the northwestern corner of the Arabian Block is relatively simple. The Rift Valley constitutes the block which sank down the middle of the anticline of which the broken margins form the uplands on either side, a plateau which slopes steeply westward toward the Mediterranean, and merges eastward into the Syrian Tableland. Detailed surveys reveal significant local complications, so that both sides of the Rift Valley exhibit diversified elevations and landscapes; volcanic eruptions have profoundly affected the basic geologic structure and in the basalt massif of Homs have even interrupted the Rift Valley; structural depressions break through the wall of the western plateau; pronounced Alpine influences are revealed in the Amanus and Cassius-Kurd Dagh Ranges, even though the valley between resembles the general rift structure farther south.

More important, however, than the physiographic background is the climatic régime, because of its importance in the economic development. Where the rainfall is adequate for agriculture or irrigation economy, the population is dense; where the rainfall diminishes to permit only pastoral occupancy, the population is sparse; and finally the desert precludes the possibility of any activity but travel and transportation. Throughout the section, the Mediterranean rainfall régime controls the economic life. The winters afford the precipitation, and the summers produce aridity and heat. Certain distinctive elements in the régime are worthy of note:

1. The amount of precipitation decreases gradually southward as is strikingly exemplified along the coast west of Palestine, where Haifa receives 27 inches of rain, Jaffa 21 inches, Gaza, 17 inches, and the Sinai Peninsula practically none at all.
2. Elevation, and direction of mountain range, unduly influence the amount of precipitation. The high Lebanons have heavy rain and snow since the rain-bearing winds must rise over them. The mountains of the Cassius Range, bordered by depressions, have relatively low rain, since the rain-bearing winds, instead of rising over their crests, pass through the depressions about them.

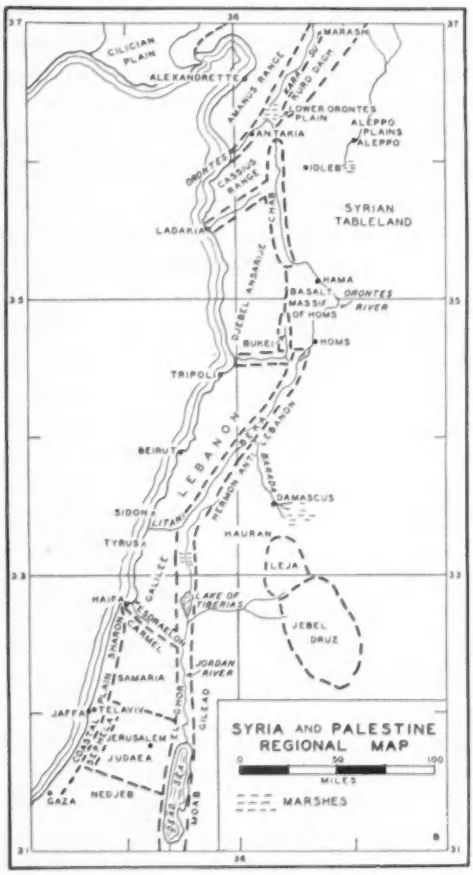

FIGURE 12.—The historically important coastal region of Syria and Palestine is best treated separately, but it falls characteristically within the limitations of the criteria established for the major Near East Region. Its varied terrane produces significant local minor variations in agricultural characteristics and cultural adaptations.

3. The Rift Valley is uniformly dry except where westward breaks and depressions open an inlet for the Mediterranean winds.
4. Wherever the eastern edge rises considerably, or higher than the corresponding western side, the amount of rainfall increases.
5. Rainfall everywhere diminishes eastward; on the Syrian Plateau it never exceeds 10 inches.
6. The Antioch-Aleppo depression permits the passage of the westerly winds bearing moisture to the Kurdistan Mountains in northern Mesopotamia.

With these distinctive elements established, it is possible to give a more detailed description of the local conditions of land utilization.

WEST OF THE RIFT VALLEY

A number of distinct subregions or sections may be distinguished west of the Rift Valley as follows: the Amanus Range; the Orontes Outlet; the Cassius Range; Cyprus; Djebel Ansarije; the Lebanon; Galilee; the Vale of Esdraelon; Samaria; the Judaean Plateau.

The Amanus Range

Analogous to the Taurus Mountains of Asia Minor, the Amanus Range rises to an elevation of five or six thousand feet. Despite its high rainfall, it is sparsely populated. The slopes facing westward are deeply eroded and generally covered with forest. The range rises so abruptly from the Mediterranean that no coastal plain is possible. The eastward slopes are steep fault escarpments that face the valley.

The Orontes Outlet

The Orontes Outlet is a low gap (250 feet) through the western edge of the Rift Valley whereby the Mediterranean once connected with the Rift graben. The gap is a structural syncline. In this gap the Orontes has cut a narrow valley which widens eastward. The moist western winter winds carry sufficient rainfall for successful agriculture on the lower slopes and terraces, and in the east the ancient city of Antioch (now

Antakia) stands in the midst of beautiful gardens of vine and fig and olive, and groves of mulberry trees.

The Cassius Range

The limestone hills of this range and its slopes are desolate and unproductive, because of the lack of rain due to the failure of the winds from the Mediterranean to rise directly over the elevations; they pass to either side by the low depressions which border the range.

Cyprus

The Isle of Cyprus is the westward continuation of the Amanus-Cassius Ranges with the depression extending longitudinally between. The mountains still bear relics of the former forest cover, and heavy mantle of maqui where the forest has been removed. The central valley, which constitutes the economic part of Cyprus, is characteristically hot and dry in summer, but rainy enough in winter to produce wheat and, where irrigation is possible, considerable fruit. While some authors wax enthusiastic and poetic over the beauty of the islands, others, more practically minded, stress the difficult agricultural conditions, the danger of floods at the time of the winter rains, and the frequent plagues of locusts.

Djebel Ansarije

South of the comparatively well-watered, densely populated valley at the mouth of which Ladakia is situated, a valley of fertile soils and productive Mediterranean agriculture, lies the extensive section known as Djebel Ansarije, economically more important than any of the regions west of the Rift hitherto discussed. Lying between four and five thousand feet above the Mediterranean from which it is separated by a narrow, coastal plain, this region of westward-facing slopes and uplands and well-watered valleys is almost all arable. Wheat and barley form the chief cereal crops; Mediterranean fruits, like oranges, figs, and melons, are abundant; mulberry trees upon which sericulture is based border the fields and roadways; and tobacco enough for some export is cultivated.

The Lebanon

From the Tripoli-Homs Depression extends the main Syrian Mountain chain, the Lebanon, of which the summits rise over ten thousand feet above the sea. Because of the limestone terrane, the mountains are of Karst character, and despite heavy precipitation, mostly in the form of winter snow, support true forest only in limited sections—Mediterranean maqui characterizes the heights, for of the famous Lebanon cedars, only a few groves are left. The coastal plains and lower slopes are intensively cultivated, and though they are so limited in extent and restricted in agricultural population, they represent one of the most prosperous sections of Syria-Palestine economically. The limited space for agriculture has directed the activities of the people chiefly to the sea, and Tyre and Sidon are now, as they have been throughout their history, dominantly maritime. They represent the type of human aggregation of the region with beautiful diminutive walled gardens surrounding substantial homes. Beirut is today the principal city of the section, from which thousands of Syrians, unable to wrest a living from the diminutive tracts of soil, emigrate to the four corners of the world.

Throughout history, the westward-facing slopes of this region have continued agricultural importance with fertile fields of grain, and luxuriant gardens of fruit, and groves of mulberry trees, bordering small fields of tobacco, indicating how productive the region still remains.

Galilee

Galilee, divided from the high Lebanon section northward by the valley of the Litani, forms the northernmost region of Palestine. The rolling uplands of Galilee differ conspicuously from the rugged ridges of the Lebanon. Though the rainfall is considerably less than that of the regions to the northward, it still remains adequate (20 to 25 inches) for the cultivation of wheat, barley, maize, and sesame. The soils are generally fertile, especially along the eastern border where basalt replaces limestone.

The Vale of Esdraelon

The vale of Esdraelon possesses the same favorable soils as Galilee. The fertile plain of Esdraelon is famous in biblical history as is the plain of Jezreel farther east, and the coastal section north of Haifa, westward. Together they form the center of the post-war Jewish settlements. The rainfall diminishes noticeably, and constitutes a definite limitation upon the success of the agriculture of the region. It is in this section that the Jewish immigration and purchase of the land from the Arabian small landholders has led to strained political relationships, so that the successful agricultural progress of the immigrant Jews is counterbalanced by the interracial hate and jealousy that has been engendered.

Samaria

Samaria in many ways resembles Galilee in its open, rolling landscape; its arable, relatively fertile limestone soils; and its well-cultivated fields of wheat and barley, and olive groves on the terraced slopes. A broad coastal plain borders the Samaritan uplands—the plain of Sharon—and continues southward. Behind the wall-like array of dunes which stands along the coast, fertile alluvial lowlands, with sufficient rainfall in winter, and in summer available ground water for pumping, have nourished a fairly dense population from the days of ancient Philistia to the present period of Zionist settlement.

Fields of grain and irrigated fruit gardens, surrounded by palms and eucalypti, extend from Mount Carmel southward to Gaza, where the increasing aridity puts an end to fruit growing and replaces crops of wheat and barley with extensive steppe pastoralism. These coastal plains grow the celebrated Palestine oranges, in groves of which, Tel Aviv, the new Jewish suburb of Jaffa, stands like a gem. The suburb is also the center of the watermelon and Palestine wine industry. In 1928 more than 2,000,000 cases of oranges and lemons, representing a value of almost three and a half million dollars, were exported.

The Judaean Plateau

Separated from this southern coastal plain of Sharon by the depression of Sephela, a highly cultivated valley between barren limestone slopes which represents a transition from the coast to the inland plateau, lies the famous Judaean Plateau, which in the north, drops off steeply to the lower lands of Samaria. The

plateau of Judaea is a rugged upland, cold in winter and hot in summer, with stony and refractory soils. It is not favorable for agriculture because of the diminishing rainfall which in the south becomes inadequate for crops. Its inaccessibility ensures safety from marauding tribes surrounding it, and, in spite of its unfavorable conditions, agriculture has been developed. Wherever the soil permits, barley and wheat are grown; on the terraced slopes, olives and grapes and figs flourish. In many places the only water available comes from deep wells from which the water was laboriously lifted. Where any cultivation at all is impossible, scattered sheep and goats roam the limestone hills, seeking pasturage in the scrub vegetation. The fault escarpment of Hebron separates Judaea from the dry Nedjeb southward. In the Nedjeb nomadic pastoral land utilization dominates because the lack of rain so strictly limits the possibilities of agriculture. At Gaza, luscious dates ripen. Farther southward, the Sinai Peninsula continues as extreme desert with conditions similar to those beyond the Gulf of Suez and the Suez Canal in Africa.

THE RIFT VALLEY

Where the plateau of Judaea terminates abruptly in a steep escarpment facing the Dead Sea and the Jordan Valley begins the Rift graben, in which lies the Dead Sea with its surface, 1,300 feet below sea level. The southern continuation of the Rift Valley rises from the Dead Sea to 1,000 feet above sea level connecting obviously the Syrian-Palestine Rift Valley with the Gulf of Akaba, and the Red Sea. Whereas the shores of the Dead Sea are almost everywhere too steep for any cultivation of the land even if conditions would permit, the Jordan Valley (the famous El Ghor) is too extremely hot and dry for any land use except on a few scattered oases where water from wells is attainable and for some nomadic occupancy in winter. Because the alluvial plain lies well above the bed of the river, irrigation is difficult at present, but there is abundant evidence that in ancient times, the fertile soils were well watered and productive and the population dense. Where the Esdraelon depression enters the Rift Valley, the precipitation is heavier because of the absence of a substantial wind barrier westward. About the Sea of Galilee (the Lake of Tiberias) and also farther north where the valley lies above sea level and the Jordan can be used for irrigation, some agriculture has been developed chiefly by Jewish settlers.

The Beka is that section of the Rift Valley occupied by the Litani and upper Orontes between the Lebanon and Anti Lebanon Ranges. It is located at an elevation of three to four thousand feet. Inadequate rain results in steppe vegetation, but where irrigation is possible, as near Homs in the most northern section, crops and fruits replace the grassland. The basalt massif of Homs, around which the Orontes River flows, interrupts the direct continuation of the Rift. West of the massif the tectonic basin of Bukei seems to show Rift affinities; in this basin, agricultural conditions are similar to those of the Beka. North of the Homs massif the Orontes River regains the Rift, the graben here being known as the Chab, a region characterized by steppe vegetation, but well watered in late winter and early spring by the freshets of the

Orontes. The overflow at this season forms swamps that cause unhealthful conditions for human occupancy in summer. Irrigation would make the fertile soil exceedingly productive, particularly for cotton, but capital adequate for the suppression of disease and the construction of adequate irrigation works must first be forthcoming.

A steep canyon connects the Chab with the lower Orontes plain, a swampy region not well drained, and with the valley of the Kara Su. The Karu Su Valley closely resembles a longitudinal depression between Alpine Ranges. Economic development is concentrated in the northern part where the town of Marash, surrounded by fields of grain and tobacco and gardens of fruit, enjoys the climatic advantages of the piedmont of the Kurdistan Mountains.

EAST OF THE RIFT VALLEY

Aridity is the most conspicuous and dominant element of the climate throughout the terrane east of the Rift Valley except where a higher elevation in the terrane itself or a lower depression westward permits higher precipitation.

The Kurd Dagh

In the north, the Kurd Dagh shows on its steep western escarpment facing the Rift, the effect of increased moisture in its groves of pine and meadows of grass, but the dry eastern slopes are desolately barren. Climatically important is the large gap south of the Amanus and Kurd Dagh Ranges by which the rain-bearing winds from the Mediterranean bring the Aleppo Plains considerably more moisture than most of the interior plateaus. Wheat and barley are grown by dry farming methods, and water flowing through the poplar-fringed rivers irrigates gardens of fruit. Aleppo is the most important trading center and market place.

Adequate rain continues southward east of the Chab where the country about Idleb produces its well-known cotton. Southward from Idleb rainfall rapidly decreases and steppe nomadism takes the place of crop agriculture except on the plain of Hama which, irrigated by water from the Orontes, forms a verdant center of productivity and culture in a desert-like environment. On the Syrian Tableland stands Palmyra, the northernmost station of date palm culture. Palmyra is now but a vestige of the great city which once shone in glory as a center of extensive production, with water brought from the distant mountains.

The Anti Lebanon Mountain

The Anti Lebanon Mountain and the Hermon Range southward rise more than 9,000 feet above sea level. The higher parts, well watered and clothed with vegetation, contrast vividly with the dry, brown, lower slopes, particularly on the eastern side. The waters of the Barada River, where it issues from the mountains, make the great Damascene oasis, of which Damascus is the jewel-like center, a luxuriant garden of fruit trees. The seven branches of the Barada water a tract of 150 square miles of emerald oasis set in a brown desert where only occasionally low steppe grasses find moisture enough to grow.

The eastern edge of the Jordan Valley and the Dead Sea are higher than the western plateau and consequently receive sufficient precipitation for the cultivation of grain.

Hauran is the principal wheat-producing section of southern Syria; considerable grain is also grown on the higher parts of Gilead and Moab in Trans-Jordania, but the croplands are exposed to the invasion of nomad tribes from the neighboring steppes and to the encroachment of clouds of locusts in certain seasons. Farther southward where streams flowed through a break in the high western wall toward the Rift, the oasis city of Petra, historically famous, formerly dominated the region. Everywhere the productive zone is narrow and restricted by the encroaching steppe.

The great volcanic massif, the Jebel Druz, with its northwestward lava outflow, the Leja, lies southeastward from Damascus. Here live the powerful, though numerically few, Jebel Druz tribesmen, who grow crops of wheat and corn, and cultivate luscious grapes on the fertile soils wherever the higher elevations produce a little more than the ordinary rainfall.

MANCHURIA: THE LAND AND ITS ECONOMY

John R. Stewart

MANCHURIA, also known as the Three Eastern Provinces, is situated in the northeast corner of the Chinese Republic, in the broad angle formed by Siberia, the Russian Maritime Province, and Korea. Few regions in Asia can equal it in political and economic importance. This undeveloped territory is attracting each year hundreds of thousands of Chinese immigrants in a large-scale colonization movement of historic significance. Its fertile plains contribute the bulk of the world's supply of soy beans. The contact in Manchuria of the tides of Chinese, Russian, and Japanese expansion have made of it a diplomatic battleground and a prolific source of international contention.

Physical Conditions

Manchuria is composed of three provinces — Fengtien, Liaoning, or Mukden province; Kirin province; and Heilungkiang or Amur province. The total area of Manchuria has never been accurately determined, and estimates vary from 360,000 to 400,000 square miles. This uncertainty as to territorial extent is attributable to the fact that while the international frontiers on the north and east are definitely delimited, the western boundary with Inner and Outer Mongolia is highly unstable. The Chinese provincial authorities are constantly extending their jurisdiction as the tide of agricultural settlement penetrates further into pastoral Mongolia.

Frequently, Manchuria is separated into North and South Manchuria. Although no physical or political basis for this division exists, the expressions are used to designate the respective spheres of influence of Russia in the North and of Japan in the South. North Manchuria is that area north of Changchun which is economically tributary to the Chinese Eastern Railway; while South Manchuria is tapped by the South Manchurian Railway.

RELIEF

From a topographic standpoint, Manchuria consists of a great interior plain surrounded by low mountain ranges. Between the Changpai Mountains in the East and the Khingan Mountains in the North and West stretch the wide plains of the Liao, Sungari, and Nonni River valleys. Since the watershed between the basins is insignificant, the great central plain of Manchuria stretches in a northeasterly, southwesterly direction from the mouth of the Sungari to the Gulf of Liaotung and shading off gradually into the Mongolian plain on the West. There are many similarities between this central plain and the western plains of the United States and Canada.

CLIMATE

Climatically, Manchuria may be included in that general type known as humid continental with short summers. Yet there are several distinctive features of Manchurian climate which distinguish it from sur-

FIGURE 1.—On the rolling grasslands of Manchuria pastoral nomadism has been the distinctive form of land utilization, but with the utilization of artesian stores for potable water, these great grasslands are being converted into productive crop lands. Herding sheep is still widespread, however. (Courtesy of South Manchuria Railway Co.)

rounding territories and from similar regions in other continents. Several climatologists have recognized a separate Manchurian type which is characterized by at least five months with a mean temperature below the freezing point, and a mean annual temperature below 10° C. The growing season is limited to five or six months; the rivers are frozen from four to six months; and the annual rainfall varies from 40 to 60 centimeters, with a summer maximum. The main features of Manchurian climate are the response to its continental location on the edge of the Central Asian land mass. The monsoon influence is dominant, for the alternating winter highs and summer lows over the dead heart of Asia cause cold, dry winters with prevailing winds from the center of the continent and warm, moist summers as the rain-bearing winds sweep in from the ocean. The cyclonic influence is comparatively unimportant.

The climate of Manchuria is continental, subject to decided extremes of temperature, and is directly affected by its proximity to the Mongolian and Siberian plateaus. The seasonal range of temperature is wide. At Harbin, for example, the range between the January and July averages is 82° F. The rainfall is light, but since it is concentrated in a summer maximum, it is adequate for agricultural purposes. Despite its extremes, the climate is healthful and invigorating and the winter cold is endurable if heavy furs and warm woolen clothing are worn. Although the menace of drought during the period of early plant growth is a handicap, the climate is favorable to the cultivation of cereals and beans. The summer rains never entirely fail, though they are frequently delayed to the detriment of growing crops; and the cool, dry autumn season permits the harvesting of crops under auspicious conditions. The winters are intensely cold since the prevailing winds descend from the atmospheric gradient over Mongolia. The snow cover, however, is light, rarely reaching any considerable depth, which facilitates a surprisingly large volume of cart traffic over the frozen roads. The spring season tends to be windy, and the central plain is occasionally plagued by clouds of dust carried by violent windstorms from the Mongolian desert. The summers are warm, often disagreeably so during hot spells. The days of sunshine

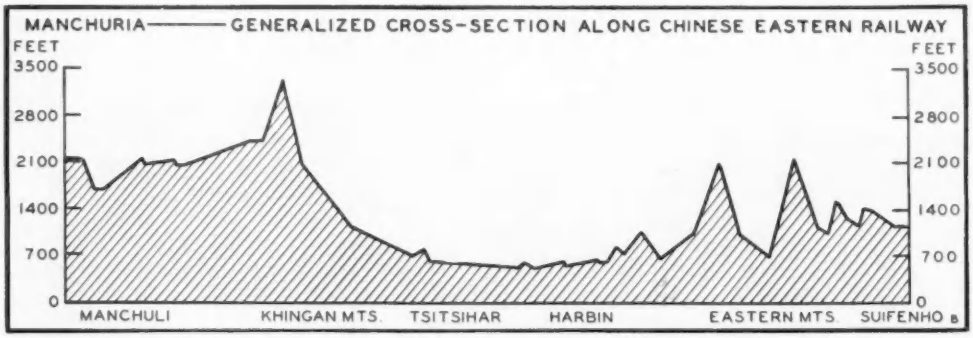

FIGURE 2.—The general plan of relief of Manchuria is clearly brought out by this cross-section.

are numerous since the precipitation comes in the form of convectional showers after which the sky quickly clears.

GEOGRAPHIC DIVISIONS

Over so large a territory as Manchuria, whose area is but slightly less than that of France and Germany combined, it is natural that there should exist many differences of topography, climate, resources, and location and of resulting economic adjustment to them. For that reason, Manchuria may be divided into six main geographic regions; namely,

(1) The Liaotung-Yinkou commercial and industrial region.
(2) The Eastern Mountains.
(3) The Central Plain of Manchuria.
(4) The Jehol hill country.
(5) The Khingan Mountains.
(6) The Barga pastoral region.

Liaotung-Yinkou Commercial and Industrial Area

Of all the regions of Manchuria the Liaotung-Yinkou area alone may be marked out as the region in which commercial and industrial activity is dominant. Its commercial development has been due to its accessibility, to its maritime location on Manchuria's limited stretch of sea-coast, to its excellent rail and water transport connections with the interior, and primarily to its location at the mouth of the Liao Valley, traditionally Manchuria's main trade route. Manchuria is roughly shaped like a huge cornucopia whose wealth of farm, forest, and mineral products pours through the narrow Liao corridor. The region includes Dairen and Yinkou, which between them handle 67 per cent of Manchuria's foreign trade. These ports have as their hinterland the Liao Valley, the most densely populated and productive part of Manchuria and in addition compete with Russian Vladivostok for the trade of North Manchuria. The transport advantages which the region possesses also account for the development of industry which benefits by the security which Japanese protection affords. Although commerce and industry are the predominant activities, agriculture is also highly developed. Despite the handicaps of poor sandy soil and rough topography, an intensive agriculture utilizes all available land in the production of rice, cotton, maize, vegetables, and other crops; for the longer growing season, warmer climate, and proximity to markets favor intensive cultivation. The terraced slopes and

valley bottoms resemble the Japanese rural landscape. The significant feature of the agriculture of this region is its adaptation to rough topography; whereas the typical Manchurian farming is conducted on the central plain under different soil, climatic, and topographic conditions.

dead volcanic peak of Peih-tu-shan 2,400 meters high. Here, where the mountains reach their greatest height and breadth, the rainfall is the heaviest in Manchuria, and several important rivers, notably the Sungari, Yalu, and Tumen, find their sources in the snow-covered heights.

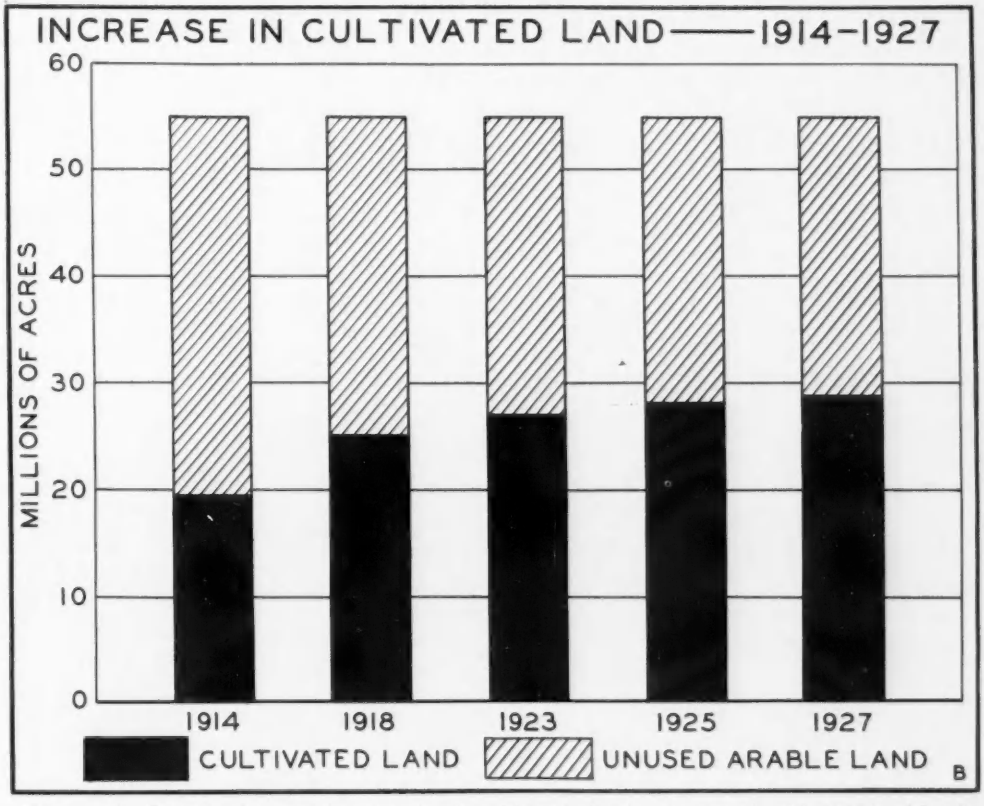

FIGURE 3.—Despite the great immigration into Manchuria, the acreage of cultivated land has increased but slightly, though steadily.

The dominant maritime nature of this region is also illustrated by the development of the fishing industry.

Eastern Mountains

The Eastern Mountains, which occupy the entire eastern part of Manchuria, consist of a series of moderately high ranges which, although seldom rising above the 1,000 meter elevation, culminate in the

The Changpai Mountains are composed chiefly of ancient rocks which through ages of weathering have been worn down into rounded summits and broad valleys. They are an extension of the old Shantung massif. The ranges are heavily forested with a fine mixed stand of coniferous and broad-leaved trees. Commercial lumbering operations in Manchuria have been largely confined to this

region. The Changpai Mountains, moreover, are richly endowed with mineral resources, particularly coal and iron, whose exploitation is proceeding on a large scale. Although the mountains are penetrated by three rail lines, population is still scanty. Agriculture is carried on in the river valleys and is capable of considerable expansion if the arable lowlands are cleared of forests. The mining, lumbering, and farming possibilities of the eastern ranges are attracting a substantial proportion of the annual immigration into Manchuria.

Central Plain

The Central Plain is the heart of Manchuria and is the site of a rapidly expanding pioneer agriculture whose chief features are the cultivation of soy beans and a variety of grains. In contrast to the surrounding forested ranges, it is a grassland country whose fertile soil and level to rolling topography are admirably adapted to cereal cultivation. The plain is drained by two large river systems which, before the construction of railroads, were the main channels of communication. Although devoid of mineral and forest resources, this interior lowland supports a prosperous and expanding agriculture which is the mainstay of the Manchurian economic system. The Central Plain is in all ways the economic heart of Manchuria; for it has within its borders the bulk of the population, railway mileage, cultivated land, and the entire navigable river system, and supplies in addition the major share of Manchuria's export trade. It is capable of subdivision into four sub-regions on the basis of the major drainage divisions; namely, the Liao Valley in the South, the

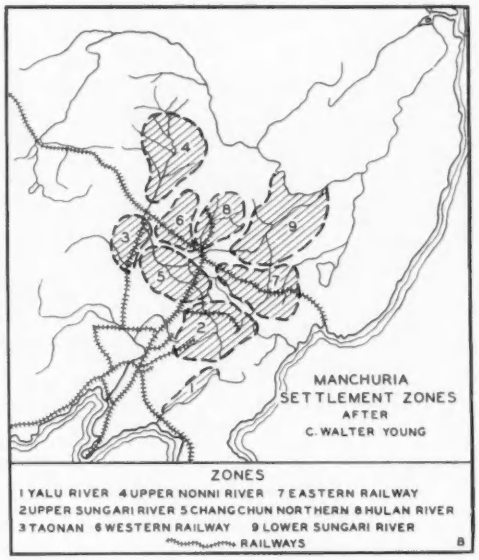

FIGURE 4.—The settlement zones of Manchuria into which heavy immigration has poured for over a decade.

Sungari plain in the Northeast, the Nonni valley in the Northwest, and the semi-arid region of interior drainage and salt lakes in the West. These sub-regions differ in the degree of density of settlement and intensiveness of cultivation.

Jehol Hills

The Jehol hill country is the smallest and least important of the regions, and consists of a fringe of rough and barren hills which extend into Manchuria from the eroded and worn-down mountain mass of Jehol Proper. Supporting no forest growth, the hills are a barren waste, in many cases eroded into bad-land country, on whose scanty pastures scattered Mongol herdsmen graze their flocks.

Khingan Mountains

The Khingan Mountains are the mountain barrier which separates the Central Plain from Siberia on the North and Mongolia on the West. Their moderate height, however, is

FIGURE 5.—Stock-raising remains an important phase of land utilization in Manchuria. (Courtesy of South Manchuria Railway Co.)

insufficient to shelter the plain to any noticeable degree from the winter winds of frigid Siberia. The Khingan Mountains consist of two groups —the Little Khingans in the North and the Great Khingans in the West, uniting to form the right angle which encloses the valley of the Nonni. The Little Khingans are the lower range and are composed of hard ancient rocks weathered down to a moderate and mature relief. The Great Khingans, however, are the sharply dissected escarpment of the Mongolian Plateau. Both ranges support a good forest cover and receive a rainfall slightly in excess of the surrounding plains. Except for minor lumbering operations in the vicinity of the Chinese Eastern, the mountains remain undeveloped and sparsely populated. Hunting and trapping, a little sheep-raising, and placer gold mining constitute the limited human use of the region. Its fine stands of timber and its rumored mineral resources may bring a future development if the handicap of isolation is overcome.

FIGURE 6.—Soy beans in open storage at Supingkai Station awaiting shipment. Supingkai is one of the produce centers in Manchuria. (Courtesy of South Manchuria Railway Co.)

Barga Pastoral Plateau

The Barga region is distinct from the rest of Manchuria. It is a high plateau, shut off from the Central Plain by the Khingan barrier, and has a semi-arid steppe climate of the

Mongolian type. It is inhabited by a nomadic, pastoral people, the Bargut Mongols, over whom the Chinese Government exercises a nominal sovereignty. A simple pastoral society, typically grassland, has developed in response to geographical conditions. The cold climate and light precipitation limit the possibilities of agriculture, but the rainfall is sufficient for the growth of grass. On these scanty pastures the Barguts graze their herds of sheep, cattle, goats, camels, and ponies. When the pastures are exhausted, the nomads fold their tents and move in search of new grazing grounds. The herds supply all the necessities of life—milk, cheese, meat, and fats for food; wool and hides for clothing and tents; and a surplus of wool, hides, hair, and live animals which may be bartered to the traders along the Railway in exchange for millet, firearms, and other goods. It is a self-contained economic existence, a nomadic subsistence pastoralism, developed under the environmental conditions of a cold, isolated, interior steppe. For racial and economic reasons, the pastoral Barguts have never accepted the exercise of Chinese sovereignty. Complete autonomy has been enjoyed in the past; and at present a secession movement is being fostered by the Soviet Government.

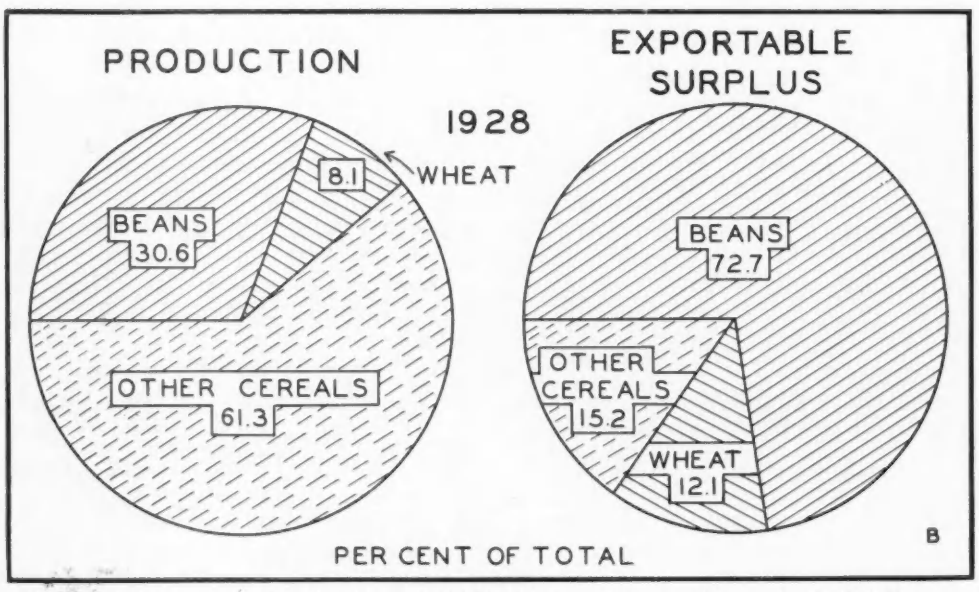

FIGURE 7.—The production of soy beans is 3,400,000 tons, the exportable surplus 2,400,000 tons; of wheat the production is 900,000 tons, the exportable surplus 400,000 tons; of other cereals the production is 6,800,000 tons, the exportable surplus 500,000 tons.

ECONOMIC ACTIVITIES

Agriculture represents the dominant economic activity and the main source of wealth of Manchuria. Not only does farming support the bulk of the population, but it also supplies the raw materials, the preparation of which constitutes the primary activity of manufacturing industry.

AGRICULTURE

Complimentary titles, such as "The Garden of China" and "The Granary

of Asia" have been applied to Manchuria to describe the productiveness of the region. The Central plain is adapted by nature to be a rich farming region, for environmental conditions are favorable. The land is level or slightly rolling; and since it is a treeless, grass-covered plain, the beginning of cultivation requires only the turning of the sod. The rainfall, though light, is adequate for farm purposes due to the summer maximum during the growing season. The numerous days of sunshine foster plant growth, while the cold, dry autumn season provides propitious conditions for the ripening and harvesting of crops. The soil, too, is deep, generally fertile, and easily worked. The soils fall into that general class known as prairie-earths, ranging from light brown to black in color. The humus content is fairly high; and the rainfall is not sufficiently heavy to have caused any serious leaching of the chemical elements of plant food. Land transportation is easy over the level plain, and the river systems provide water routes for the shipment of products. The remarkable development of Manchurian agriculture, however, dates from the early years of the 20th century when the construction of railroads, the influx of Chinese immigrants, and the opening of world markets for Manchurian products provided the material means of utilizing the favored Central Plain.

FIGURE 8.—Manchuria soy beans awaiting shipment. Both the South Manchuria Railway (Japanese-leased) and the Chinese Eastern carry huge quantities of beans. Japan's recent appearance in North Manchuria has brought into existence a scheme of railroad building destined to parallel the Chinese Eastern and draw products of this region either to the Korean coast or to Dairen. (Courtesy of South Manchuria Railway Co.)

Cultivated Area

In 1927 the farm land under cultivation in Manchuria was estimated at 28.5 million acres, 11.7 per cent of the total area, or 52 per cent of the estimated available arable land fit for cultivation. Therefore, 26.5 million acres yet remain open for new settlement. The reclamation of unused land is believed to be proceeding at the rate of 1,000,000 acres per year, roughly corresponding to the annual immigration. In the 14-year period 1914 to 1927, the cultivated

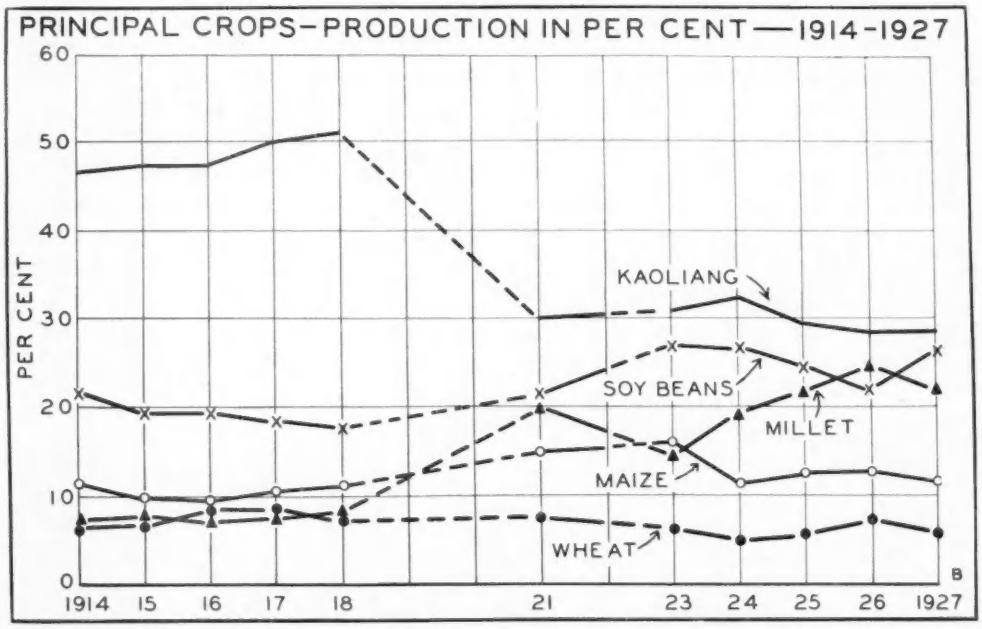

FIGURE 9.—Kaoliang, one of the sorghums, is more important than soy beans in the land economy of Manchuria. With improved agricultural methods the production of wheat is likely to increase.

land increased at the average rate of 625,000 acres per year; and it seems logical that the recent augmented immigration should account for a corresponding rise in the rate of cultivated farm land increase. The degree of land utilization varies from south to north. The Liao Valley, the region of oldest settlement, is densely populated and practically all of the available land has been brought into use. In Mukden district, for example, 95.9 per cent of the arable land is being cultivated. On the other hand, North Manchuria is inadequately farmed. For Amur Province as a whole, but 35 per cent of the arable land is being cultivated. The Chinese Eastern Railway believes that there are 45,000,000 acres of fallow land in the Nonni, Hulan, Sungari, and Amur valleys awaiting the plow of the settler. It estimates that 95 per cent of the Manchurian land reserve is located adjacent to or north of the main route of the Railway.

One of the curious features of Manchurian agriculture is the concentration of the most intensive cultivation in the Liao Valley, with a gradual thinning out as one proceeds to the North and West. Here, in the South, population is densest, the proportion of utilized land is highest, the size of farms is smallest, the intensiveness of cultivation is greatest, and the yields highest. To the North, farm holdings grow larger, settlements thinner, yields lower, and methods of farming more extensive.

Tenure

Although Manchuria is a land of pioneer agriculture, the size of farm holdings is small compared with American standards. In Mukden Province the farms range from one-half acre to 15 acres in size, with 85 per cent of the farms below 10 acres in size and with 19 per cent less than one acre. In the newer regions, however, land holdings are fairly

large, with farms over 100 acres by no means rare. In the Anta district, for example, 61.4 per cent of the farms are above 20 acres in size. Small holdings are the rule because the Chinese are by nature intensive farmers. Equally important is that crude hand methods and lack of machinery prevent large-scale farm operation.

Tenantry is a common practice, for the arriving immigrants are ordinarily so poverty-stricken that they are forced to seek employment as tenants or farm laborers. Moreover, the holdings of many independent owners are so small that they are compelled to rent additional land. Of the 1,686,000 farm families of Mukden Province, 41 per cent are rated as independent owners, 30 per cent as full tenants, and 29 per cent as owner-tenants. It is the opinion of the Chinese Eastern Railway that the heavy burdens of rentals and the harsh conditions of tenantry are the primary causes of the prevalence of banditry.

Crops

Since Manchuria has been settled by North China farmers who are farming their new home under similar climatic conditions, Manchurian crops are very similar to those grown in North China. Peculiar to the region is the dependence upon soy beans as the money crop. Other crops are kaoliang, millet, wheat, maize, rice, and barley. Cereals and beans, therefore, are the mainstays of Manchurian agriculture; technical cultures, such as hemp, tobacco, sugar beets, vegetables, and the like occupy a bare 5 per cent of the cultivated land.

Soy beans are the crop by which Manchuria is known in world markets. It is not only a money-crop, but primarily an export crop; for 80 per cent of production is exported. Beans are a staple crop on all Manchurian farms. In 1927, a typical year, 31.3 per cent of the cultivated land was planted to beans. Soy beans have developed so remarkably in Manchuria because soil and climatic conditions are favorable to its cultivation. It is a hardy plant, capable of resisting cold, drought, and disease. Its yields are reliable, a fact which accounts for its preference to wheat whose yields are fluctuating. The popularity of the soy bean is due to its high nutritive value and to the manifold edible and industrial uses to which it can be put. Thirty-eight per cent of the world's annual production of soy beans are grown in Manchuria. The acreage planted to beans is steadily rising as new lands are opened, and it is also gaining relatively over other crops. The exportable surplus of soy beans is approximately 2.5 million tons in North Manchuria and 1.5 million tons in South Manchuria. With the settlement of its extensive unused lands, North Manchuria's surplus should rise in proportion.

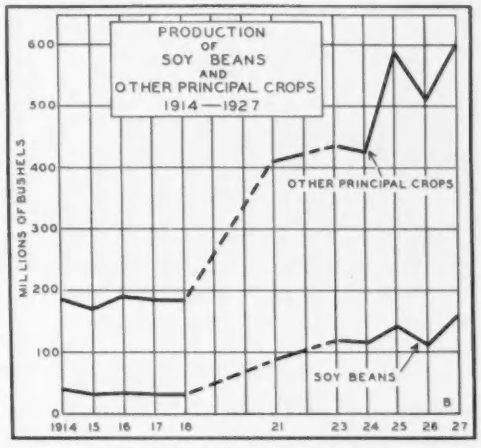

FIGURE 10.—Soy beans constitute an important part of the total crop production.

FIGURE 11.—Harvesting soy beans. The landscape is strikingly like that of central Illinois where soy beans are so successfully grown. (Courtesy of South Manchuria Railway Co.)

Wheat, another cash crop, is grown mainly in North Manchuria where soil and climatic conditions are excellent for spring wheat; but Manchurian wheat, because of its poor quality and high production costs, cannot compete in Far Eastern markets with the cheap, machine-grown wheat of the United States and Canada. Wheat production has already been reduced to a domestic basis, and is declining relative to other crops.

The other cereals—kaoliang, millet, maize, rice, and barley—are more definitely subsistence crops which are mainly consumed locally for human and animal food and for distilling purposes. Kaoliang or sorghum is most extensively produced in the South where the climate is less rigorous; whereas millet is the chief food crop of the colder North or of dry and sandy areas. Maize is the leading crop in the rough lands of the Southeast and of Liaotung. Rice, about evenly divided between paddy and upland varieties, is grown mainly in the South by Korean immigrants. The importance of these food crops in Manchurian agriculture is indicated by the facts that their total production exceeded 410 million bushels in 1927 and that they occupied in that year 60 per cent of the cultivated area.

FIGURE 12.—The millet of Manchuria is still cultivated by primitive methods. (Courtesy of South Manchuria Railway Co.)

Technical cultures have never held a significant place in the Manchurian farm economy. Sugar beets and flax have been introduced; hemp and jute are grown both for seed and fibre; a strong native tobacco is produced; and the Japanese are fostering cotton

culture in the South. In the mountains of southeast Fengtien, a specialized crop—tussah or wild-silk—is produced by cocoons fed on oak leaves.

Farm Methods

The methods of Manchurian agriculture are crude and primitive when measured by western standards. They are the adaptation of the ancient farm practices of North China to Manchurian conditions. There are certain outstanding characteristics, namely:

(1) The crude simplicity of farming tools and implements which are primitive wooden devices designed largely for manual use.

(2) The absence of modern machinery except upon a few farms operated by progressive officials. Despite the adaptability of the level plains to machine methods, their general use is precluded by the small size of holdings, the farmer's poverty, the insecurity of property, and the force of inertia.

(3) The extensive use of manual labor in tilling and harvesting.

(4) Dependence on an annual influx of hundreds of thousands of seasonal Shantung farm workers.

(5) Neglect of animal industries, both livestock raising and dairying.

(6) General use of fertilizers and of a regular system of crop rotation.

(7) The absence of fallow or hay lands from that crop rotation.

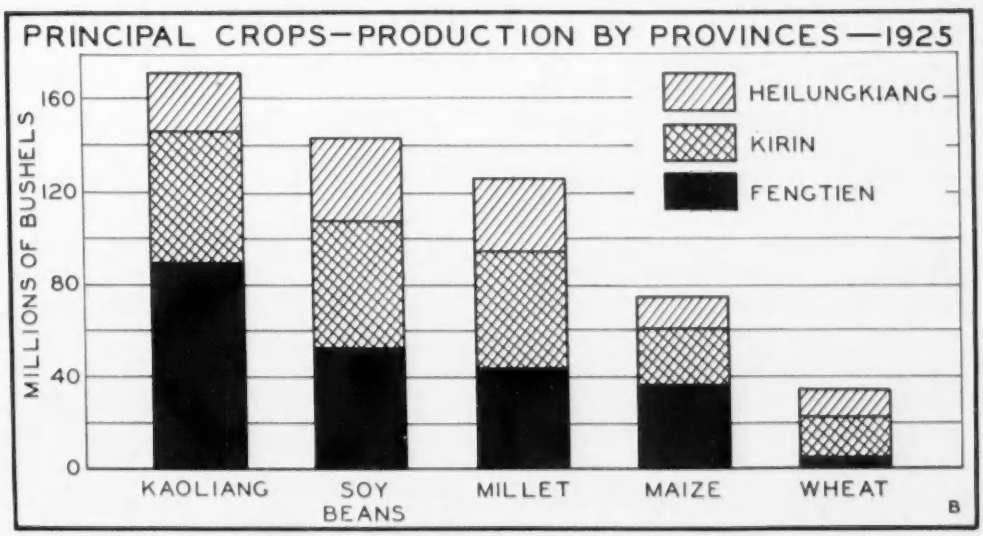

FIGURE 13.—The relative production of the principal crops by provinces indicates more clearly than words their relative areal distribution and significance.

Although farm animals are more numerous than in China, the main dependence is upon manual labor. Manchuria is a pioneer country, with an abundance of land and a shortage of labor. Yet, instead of employing the machinery which opened the American West, the Manchurian farmer, of necessity, relies upon hand labor, and to remedy the

FIGURE 14.—The distribution of the various kinds of coal in Manchuria. (Modified from map by C. Y. Hsieh, 1926.)

local deficiency imports a tremendous volume of seasonal labor from Shantung. The life of the Manchurian farmer is one of constant toil and exhausting physical effort; yet he thrives on a monotonous restricted diet of millet and beans.

Manchurian agriculture labors under many handicaps—lack of transportation in remote regions, the constant menace of banditry, heavy taxation, restricted credit facilities, shortage of labor, and burdensome rentals. Yet, in spite of these handicaps, agriculture continues to progress, production to increase, the cultivated area to expand, and the exportable surplus to rise; for the land-hungry refugee from Shantung makes the most industrious type of farmer.

MINING

The mineral resources of Manchuria rank next in importance to the agricultural productivity of its fertile plains. Coal and iron are the leading minerals, both in production and reserves; but a wide variety of other minerals have been commercially mined or their existence verified. Because of the dearth of information and lack of adequate surveys, figures with regard to mineral deposits must be regarded as estimates.

Coal

Coal is probably Manchuria's most important mineral resource, yet in comparison to the huge reserves of China Proper, the deposits are insignificant. Hsieh sets the coal reserves of all China at 217.5 billion tons, and those of Manchuria at nearly three billion or 1.3 per cent of the total. The coal fields of Manchuria are scattered throughout the region, and range in quality from semi-bituminous to lignite. The Penhsihu field alone has produced

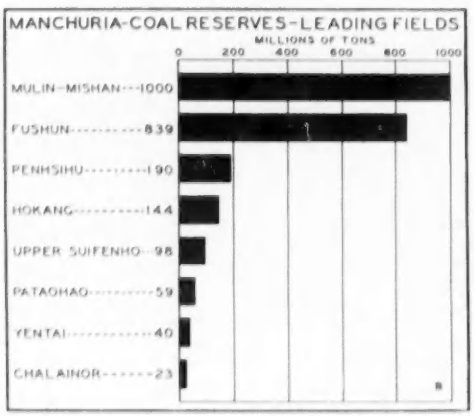

FIGURE 15.—The estimated coal reserves of Manchuria are significant in themselves, but much more so when related to Japan's insular industry. (Modified from map by C. Y. Hsieh.)

good serviceable coke; but the Hokang and Mulin fields of North Manchuria are said to be capable of producing a hard coke suitable for metallurgical purposes. The Yentai coal, verging on semi-anthracite, is an excellent steam coal. Fushun coal is

sub-bituminous; but nevertheless is suitable for gas-making, bunkering, and general industrial and railway purposes. The Chalainor mines, the oldest producer, yield a lignite of poor quality.

Although insignificant with regard to reserves, Manchuria is more important in current production. The

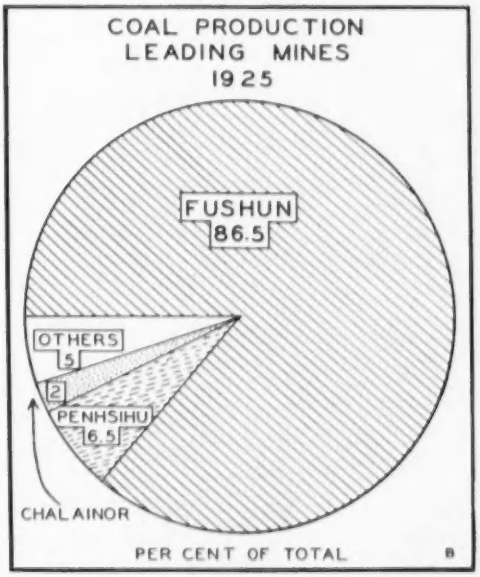

FIGURE 16.—The relative production of the leading coal fields of Manchuria. Fushun with an annual production of 5,671,000 tons is far in the lead.

Fushun mine is the largest in China, and is said to possess the largest open-pit coal working in the world. The modern coal mining enterprises of Manchuria are either exclusively under foreign control or have a small Chinese participation. The scarcity of native capital and the lack of technical skill retard the development of Chinese mines. The chief producing mines owe their development to Japanese or Russian capital operating mainly through the two railroads. Slightly less than half of the production is exported or sold as bunker coal. The exploitation of many known fields with large reserves is handicapped by isolation. Especially is this true of the Hokang field on the Lower Sungari which is capable of producing a good coke.

The Fushun coal mines, operated by the South Manchurian Railway, are the outstanding coal enterprise of China. Their production has been steadily rising. At present, three perpendicular shafts, five inclined shafts, and one large open pit and two small ones, are being worked. The great open pit, started seven years ago, is now 200 feet deep. The Fushun field is a compact deposit occupying an area of 23 square miles and possessing seams ranging from 130 to 200 feet in thickness, believed to be the thickest seams in the world. Over 1,000,000 tons of Fushun coal are annually exported to Japan. It finds a wide market in North and South Manchuria, for bunkering, and in the export markets of Japan, Korea, South China, and the Philippines.

Iron

Manchuria possesses within its borders the major share of China's iron ore resources in the form of large deposits of low-grade Archean ores. A narrow mineralized iron belt, which extends across the southern part of Fengtien Province, contains a mass of low-grade ore, in which localized pockets of rich ore appear. In three localities, where the iron veins outcrop, large deposits of ore are found—namely at Miao-erh-kou, Kungchangling, and Anshan. Miao-erh-kou and Anshan produce the entire iron ore output of Manchuria; while preliminary digging and prospecting have been done at Kungchangling. These three main ore bodies are controlled by joint Sino-

Japanese companies. The main problem is the utilization of low-grade 30 per cent ores, for the small deposits of rich ore on which the furnaces until recently have depended will soon be exhausted.

The modern iron industry of Manchuria is restricted to two plants—one at Penhsihu operated by a joint Sino-Japanese enterprise and the second at Anshan operated by the South Manchurian Railway. These iron works produce only pig iron. The significant feature about the Manchurian iron industry is that it is controlled and financed by Japanese capital and that the major share of its output is exported to Japan.

The Penhsihu Iron Works are equipped with four blast furnaces with a total daily capacity of 320 tons. Natural conditions favor low costs of production; for coking coal, iron ore, and limestone are found in close proximity to each other. The Antung-Mukden Railway, passing through the plant, provides transport facilities.

The Anshan Iron Works of the South Manchurian Railway, are Manchuria's best example of modern large-scale industry. Their construction was commenced during the war with the ambitious plan of utilizing the huge deposits of Fushun coal and Anshan iron to produce 1,000,000 tons of iron and steel per year. The Company, has, however, encountered difficulties from the start. It was initially overcapitalized due to inflated war-time costs and to the construction of a model mining town and an expensive water works. Technical preparation was inadequate, for

FIGURE 17.—The open cut, or strip, mines at the Fushun collieries. (Courtesy of South Manchuria Railway Co.)

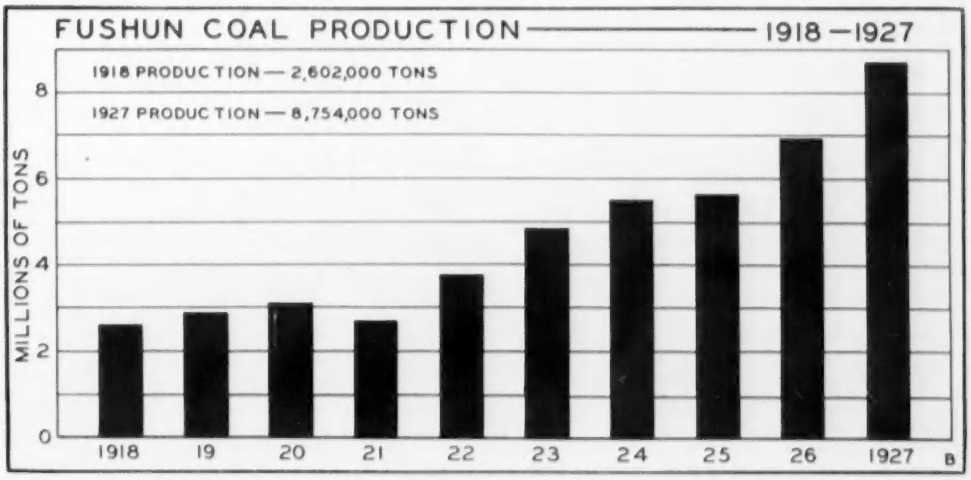

FIGURE 18.—The production of coal from the Fushun mines has steadily increased for a decade, most rapidly in recent years.

it was later discovered that Fushun coal did not coke and that low-grade Anshan iron produced an unsaleable silicious pig. The furnaces were then restricted to rich ore and to a mixture of Fushun and Penhsihu coke until the problem of utilizing poor ores was solved. With great expense the Company evolved a magnetic concentration process and installed a reducing plant. The process consists of a fine crushing to permit separation of iron from the silica; then a preliminary roasting followed

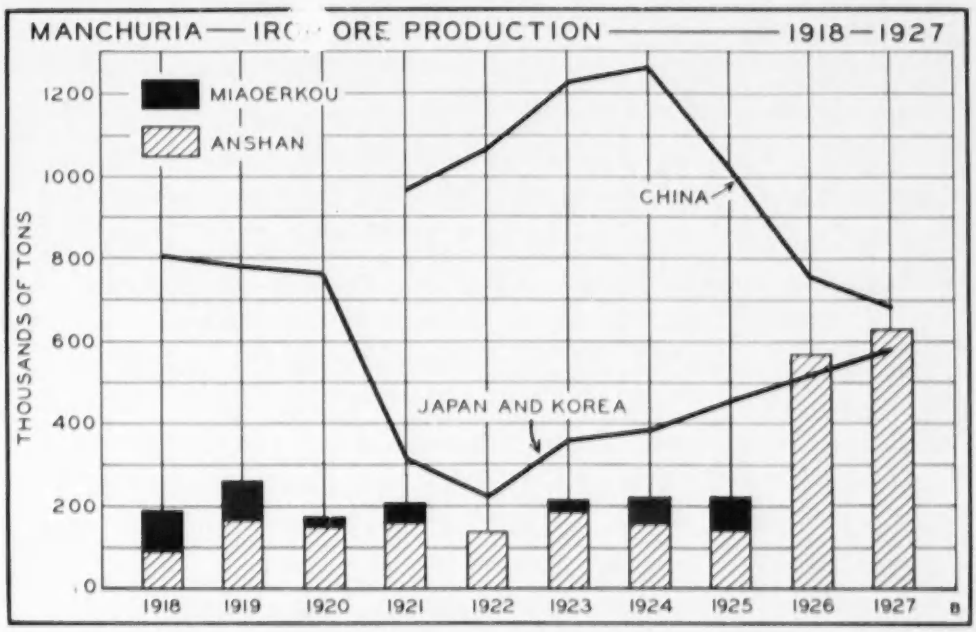

FIGURE 19.—The surprising growth of iron ore production in Anshan, the decline of Chinese production, and the recent increase of production in Japan and Korea, are significant.

FIGURE 20.—The modern iron and steel works at Anshan. (Courtesy of South Manchuria Railway Co.)

by magnetic concentration of the ore; and a final briquetting of the iron concentrate. In this way a 55 per cent ore is obtained, although half the ore is lost in the process. Two tons of raw ore are required to produce one ton of concentrated ore.

The solution of the ore problem leaves the coking problem uppermost. At present Fushun coal is mixed with Penhsihu coal in a ratio of 80:20; but the Company is experimenting with the possibility of reducing the proportion of the more expensive Penhsihu coal. The efficient open-cut mining of the ore gives a raw ore of extraordinary cheapness; but the necessity of preliminary

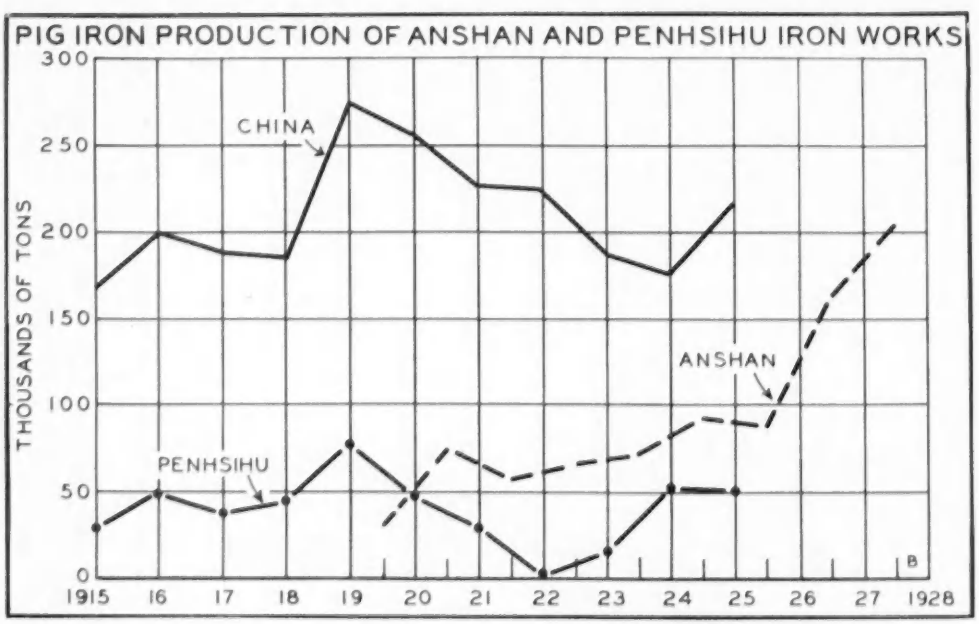

FIGURE 21.—Comparison of Manchurian and Chinese iron and steel production.

treatment and of importing coal and limestone raises the cost of production. The financial burden has been lightened by the arbitrary halving of the capitalization. When the expenses of the rail haul to Dairen and ocean freight to Japan are added, Anshan pig iron is as costly as domestic Japanese pig. Three blast furnaces with a daily capacity of 1,100 tons and four bee-hive coke ovens are in operation; while a steel plant has been completed.

Other Minerals

In addition to coal and iron, gold is mined by crude placer methods; soda is extracted from natural soda-lakes; salt is produced by evaporation along the southern coast; and to utilize the huge oil-shale deposits at Fushun, a shale-oil refining plant is being built to produce crude oil and ammonium sulphate.

FIGURE 22.—Lumber rafts on the Yalu River. (Courtesy of South Manchuria Railway Co.)

FORESTRY

In contrast to the denuded hills of China Proper, the mountain regions of Manchuria contain a wealth of forest resources which represent China's main reserves of standing timber. The preservation of these forests has been due to the isolation and sparse population of Manchuria and to the Manchu policy of restriction. Between 30 and 40 per cent of the land area is forest-covered, mostly with virgin stands of timber. The wooded area consists of a vast arc which stretches from the Korean border to Mongolia, enclosing the treeless central plain. A Japanese estimate places the timber reserve at 88 million acres containing 150 billion cubic feet of timber. This estimate is based on conjecture, since the major forest areas are found in the unsurveyed Khingans. Over 300 varieties of trees have been observed, divided broadly between 40 per cent coniferous and 60 per cent broad-leaved species. Larches, oaks, birches, and Korean pines are the most common types. The finest stands noted for the variety and size of trees, are found in the Kirin forests, where the rainfall is more abundant and the cold less severe.

Commercial lumbering operations are carried on only in the more accessible areas, in the Yalu and Upper Sungari basins and along both eastern and western sections of the Chinese Eastern Railway. Forest concessions are held by Russian, Chinese, and Japanese concerns. Lumbering methods are wasteful and destructive. So rapidly is forest production proceeding because of reckless lumbering, unrestricted clearing, and fire that many slopes have already assumed the barren and eroded appearance of Chinese hills. The forest cover should be preserved, both

as a future timber supply for the treeless plains and as a preventive of flood and erosion. The extent of lumbering operations is illustrated by the fact that it is said that 20,000 lumber rafts are floated down the Yalu to Antung each summer season. Most of the wood cut is consumed within Manchuria as fuel and building material, although quantities of Manchurian lumber are sold in Chinese and Japanese markets. The future development of the lumber industry depends on the improvement of transport facilities, for the more accessible areas have been cut over.

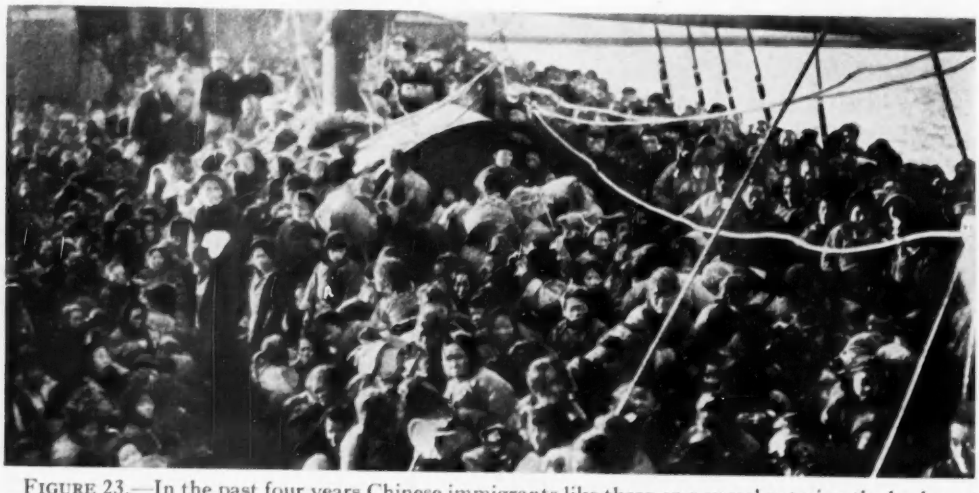

FIGURE 23.—In the past four years Chinese immigrants like these on a vessel entering the harbor at Dairen have poured into Manchuria at the rate of almost or quite a million a year, chiefly from the famine-stricken areas of North China. Many are pushing into the Mongol-Manchurian borderland. Already the Chinese population of Barga, in northwestern Manchuria, outnumbers the Barga Mongols. (Courtesy of South Manchuria Railway Co.)

MANUFACTURING

Manchuria is engaged primarily in the extractive industries—agriculture, forestry, and mining. Such industry as has developed may be classified in two main groups: (1) The preparation of farm products for export or for local consumption; and (2) The satisfaction of local needs for manufactured goods.

Throughout Manchuria crude native mills, using animal power, stand side by side large modern factories equipped with steam-driven machinery. Although the native mill is small, the aggregate production of thousands of scattered mills is considerable. Modern industry has been developed by Japanese and Russian capital, although Chinese capital is now entering the field.

The three most important industries—bean oil, flour, and distilling—are based on the utilization of farm products—the crushing of beans, the milling of wheat, and the brewing of spirit from kaoliang, millet, corn, and barley. These are the traditional industries of Manchuria which existed before the days of foreign influence; foreign capital has but improved and equipped them with modern machinery. While the flour and spirits are consumed locally, bean oil and its by-product beancake enter extensively into foreign trade. The bean-oil industry is at the parting of the ways. The future will decide whether it will decline to

a domestic basis with the raw beans being exported or whether it will be improved to produce a superior, refined, colorless oil, able to compete with domestic refining in the bean importing countries.

The other industries of Manchuria are based on the preparation of farm, mineral, and forest raw materials for market or on the meeting of local needs for finished goods. Sugar refining, vermicelli-making, weaving of sacking and cordage from hemp, saw-milling, iron-smelting, wool-washing, and tanning of hides illustrate the former group; while the latter includes the manufacture of soap, glass, cement, brick and tiles, clothing, cigarettes, shoes, pottery, paper, and the like.

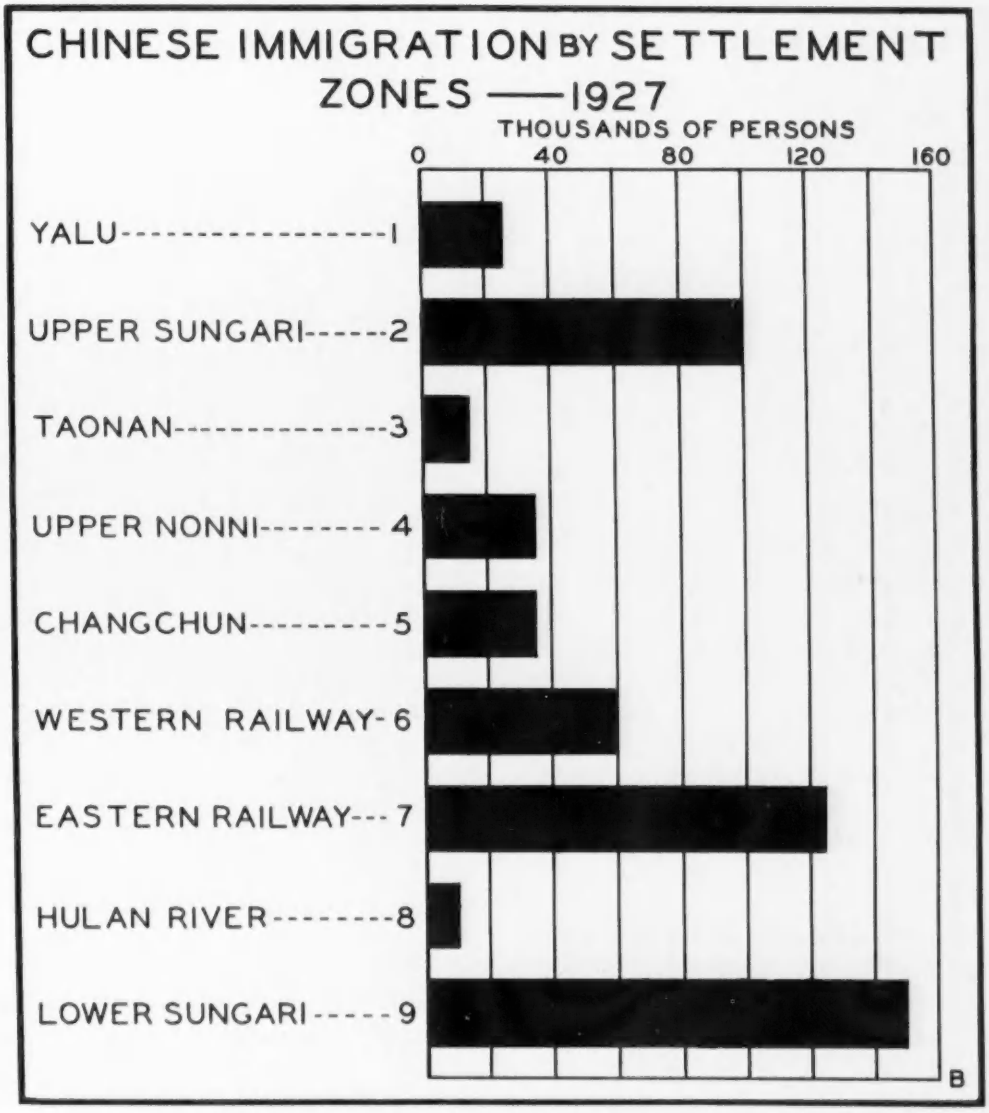

FIGURE 24.—The rate and destination of Chinese immigration into Manchuria.

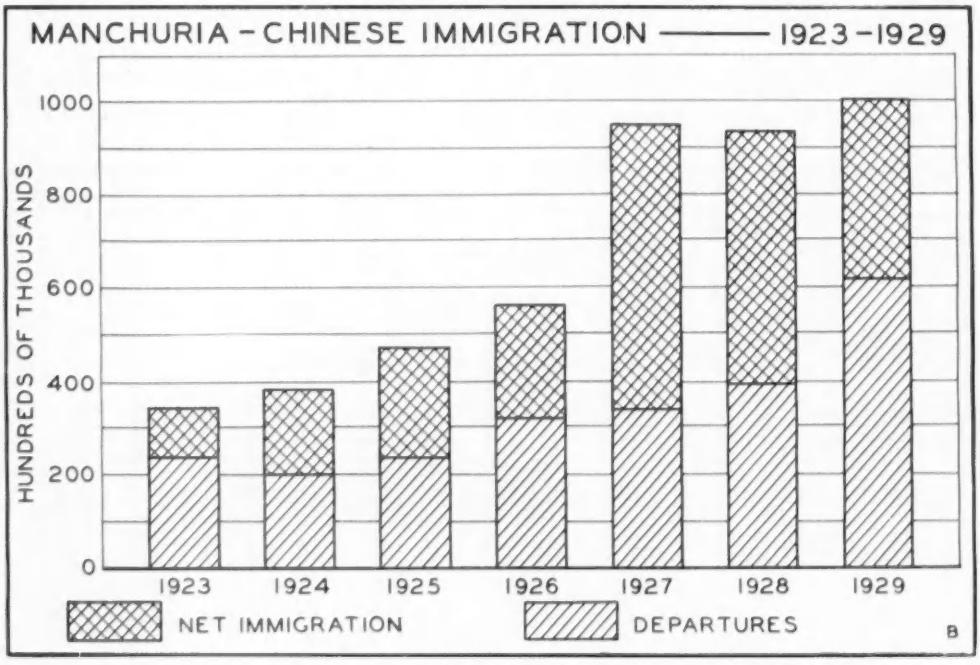

FIGURE 25.—The progress of settlement in Manchuria. The net loss in 1929 is significant.

Industrial activity is most highly developed at Dairen, in the South Manchurian Railway Zone, and at Harbin. Dairen, the leading bean-oil center, has the advantages of abundant labor supply, excellent rail facilities, and a large local market. The peace and order maintained by Japanese Railway guards and transport facilities also account for the development of industry in the Railway Zone. Japanese capital dominates the industry of South Manchuria, but Chinese capital occupies a more prominent part in North Manchurian industry. Harbin is the industrial center of North Manchuria, with flour and bean milling and distilling its leading activities. Situated at the junction of the Manchurian railway system with the great Sungari River route, Harbin is advantageously located for the assembly of raw materials and the supplying of the North Manchurian market.

Manchuria has many potential advantages for industrial development. The farm, mineral, and forest resources provide an abundance of raw materials; large coal reserves assure an adequate fuel supply; a growing population and an expanding economy present an ever-widening market; and the annual immigration assures a sufficiency of labor. Political security, improved communications, capital, and tariff protection are needed to stimulate industrial expansion.

CHINESE COLONIZATION

The colonization of Manchuria is a mass population movement which is exceeding emigration to any of the other pioneer regions of the world. The unsettled lands of Manchuria are the natural outlet for the surplus farming millions of overpopulated North China, from which emigration has been proceeding for centuries

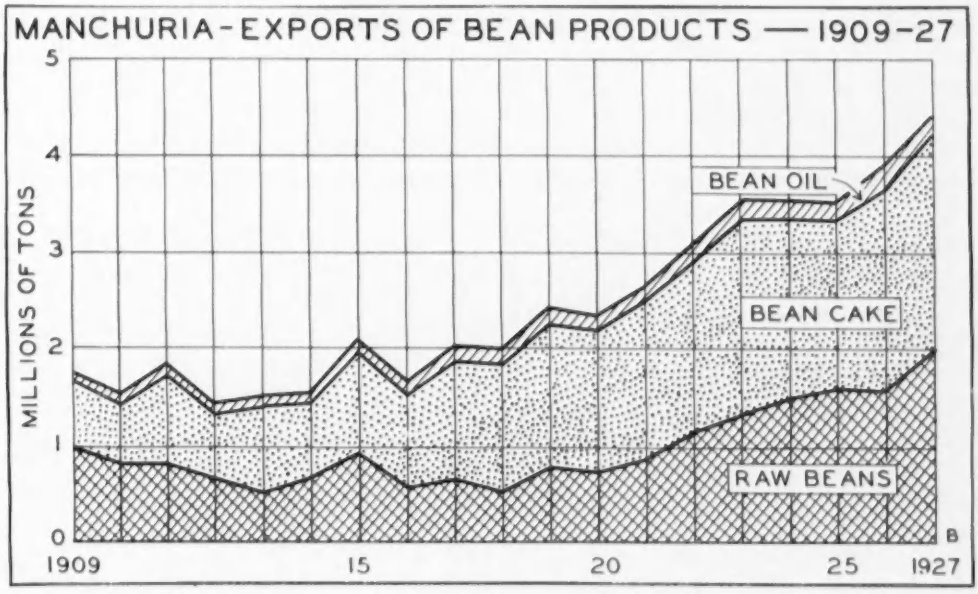

FIGURE 26.—The growing export of bean cake from Manchuria indicates how the soy bean crop constitutes the important surplus production of the Manchurian grasslands.

despite the Manchu restriction policy. But within recent years the movement has reached an unprecedented volume. Chinese colonization is of political and economic significance, because the influx of Chinese settlers cements Chinese sovereignty beyond question and makes possible the increasing development of Manchuria's undeveloped resources.

The impulses which lie back of the colonization movement have their source in the economic attractiveness of Manchuria's unused lands and in the social and economic conditions of saturated Shantung. Manchuria is the most favored single sizeable area of Chinese territory to which surplus population can migrate. Large tracts of unsettled land, attractive because of low rental and purchase rates, draw the settler; while labor is in strong demand in farming, mines, railroads, lumbering, and industry. But the Manchurian demand for labor is not the controlling factor in the tide of immigration. It is the harsh conditions of life in Shantung due to overpopulation, famine, civil war, banditry, military oppression, and extortionate taxation which are driving the starving people to seek new homes in Manchuria. It requires the combination of intolerable conditions and the lure of accessible lands to separate the Chinese farmer from their ancestral homes. The good rail and water transport routes to the settlement zones, the reduced rail rates offered to settlers, and the government aids to colonization are also contributing causes to immigration.

Within recent years Chinese immigration has undergone certain changes in character and volume. Prior to 1925, annual immigration varied between 300,000 and 400,000, the vast majority of whom were males and of whom over half were seasonal workers. Its dominant characteristic was the flow of seasonal labor of the spring-come autumn-go variety so that the spring

influx was offset by the autumn departures of returning workers. In the fall of 1926, new arrivals exceeded departures, an entirely new feature. In 1927, immigration rose to nearly 1,000,000 persons, or double the 1923–1925 average. The percentage of fall departure fell to 36 per cent, the lowest recorded point. The percentage of women and children showed a remarkable increase. Whole families were arriving with their scanty household possessions with the intention of permanent settlement. Wise observers proclaimed the character of the new immigration—a moderate flow of seasonal male workers was being replaced by a much larger volume of colonizing families. Although the percentage of departures rose to 60 per cent again in 1929, it seems true that permanent settlement is increasing; but if domestic concord returns to Shantung, it is very likely that immigration will be reduced in volume.

Immigrants arrive in Manchuria by rail or water, and are distributed by rail, cart route, or on foot to the various settlement zones. The goal for most is North Manchuria where the chief unsettled areas are found. The majority are extremely poor, destitute of everything but a bundle of household goods. Some are joining their relatives and friends, already established on farms. The more fortunate have sufficient funds to purchase a section of land, but the larger portion become tenant farmers or hire themselves out as farm laborers or workers in mines, lumber camps, docks, and railway construction. Their constant purpose is to work and save until an independent farm holding can be obtained. The patience, industry, and endurance of these land-hungry Chinese colonists are surprising, but they form the basis of Manchuria's economic development.

The provincial governments encourage colonization in various ways.

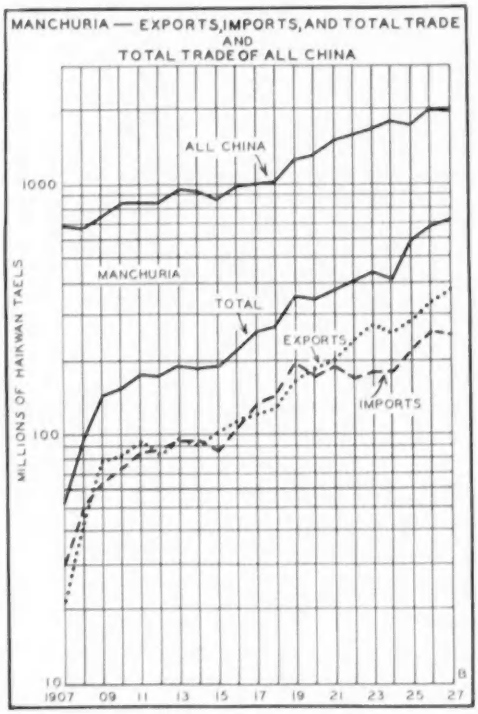

FIGURE 27.—Comparison of Chinese and Manchurian trade.

The opening of land to settlement is controlled by the Land Reclamation Bureau at Mukden. The terms of such openings are posted throughout Manchuria and North China. Officials and large landowners frequently obtain control of new areas and lease them to new arrivals in small parcels, loaning small sums to tide them over the first harvest. District authorities make attractive offers of cheap land and provision of seed, tools, and draft animals. Too often the ignorant colonist is gouged by dishonest land speculators and by corrupt officials.

The future of Manchurian colonization is uncertain. There are many millions of acres of good farming land lying fallow in the northern valleys—land capable of settlement by small farmers with limited resources. But the use of the semiarid plains of Eastern Inner Mongolia requires large irrigation works or extensive dry farming operations—both of which require an outlay of capital beyond the resources of the average settler and which can be supplied only by the government, large corporations, or wealthy individuals. But Manchuria is already more densely populated than is generally believed. The average density is 72 per square mile, or higher than in the United States. The Liao Valley is approaching the saturation point. The best lands have already been occupied; and the natural increase of population by birth is surprisingly large. The average number of persons per family is 5.5 in China; in Manchuria it is 8.8. Between 1925 and 1929, the population jumped from 18 to 27 million, an increase of over nine million in five years. The net immigration during this period was two million, leaving a net increase of population by natural birth of over seven million in five years. These figures inspire the question—will the unused lands of Manchuria be saturated by a dense population living on the Chinese level, or will these unused resources raise in some degree the living standard of the Chinese people?

TRADE

The trade of Manchuria has long been enormous. Before the construction of railways, trade moved in tremendous quantities by cart and water route down the Liao Valley to the port of Newchang. As many as 20,000 junks operated on the Liao; while the volume of winter cart traffic amazed all observers.

The construction of railways revolutionized Manchurian trade. Not

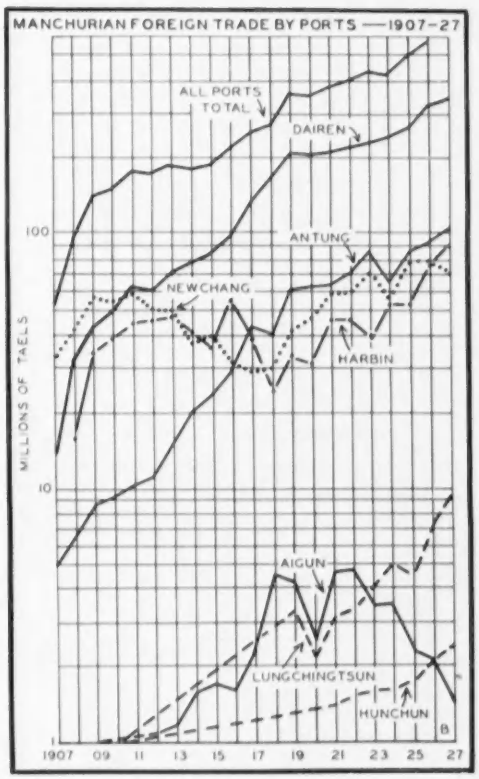

FIGURE 28.—Manchurian foreign trade by ports.

only did the railroads open new areas and permit a great increase in farm production and population; but they completely transformed the routes of trade. Dairen and Vladivostok, rail termini, replaced Newchang as the outlet for Manchurian products; and the rivers and cart routes were reduced to subordinate positions as feeders of the rail lines.

Manchurian trade has since borne certain definite characteristics:

(1) Its expansion has been rapid and consistent.

(2) A favorable balance of trade has been, with few exceptions, maintained.
(3) Foodstuffs and raw materials have constituted the exports and manufactured goods the imports.
(4) Bean products have dominated the export trade.
(5) Japan has been the leading purchaser of Manchurian products and the chief supplier of imported goods.
(6) Dairen has risen to a commanding position as the chief port.

which large sums of foreign capital have been invested, it has maintained and of late enlarged a favorable balance of trade by the export of large quantities of raw products. Even bean oil and pig iron, leading products of Manchurian industry, enter other countries as raw materials. Taking advantage of its ice-free harbor improved by modern port facilities and of its location as terminus of the South Manchurian Railway, Dairen has during this period risen to the rank of an international port, second only to Shanghai as the chief port of China.

FIGURE 29.—The wharves at Dairen are modern and excellently equipped. Dairen has become one of the important ports of Eastern Asia. (Courtesy of South Manchuria Railway Co.)

Manchurian trade has expanded more rapidly than that of China Proper. In 1908, the total trade of Manchuria represented 12 per cent of the trade of all China; by 1927 the proportion had risen to 21 per cent. This expansion has been made possible by the development of Manchuria's resources, by the investment of foreign capital, and by the existence of superior transport facilities, a larger exportable surplus, and a greater degree of political stability. As is natural in a new country in

The close trade relations between Japan and Manchuria are the natural outcome of the supplementary nature of the two economies. The densely populated, industrial islands look to Manchuria for food and raw materials, for bean cake to maintain the fertility of their rice fields, and for pig iron and coal to supplement deficient domestic production. Regardless of political privileges and investments, the trade between the two countries must naturally be large. Japanese industry is able to

dominate the import trade because of proximity and of ability to meet the demands of the Manchurian market for cheap, low-priced goods. Japanese steamers, transporting bulky raw products to Japan, are able to quote low freight rates for manufactured goods on the return voyage.

The trade with surrounding regions is also large. There is considerable border trade with Siberia; and millet is shipped in quantity to Korea. China Proper buys large amounts of millet, kaoliang, bean products, and coal. The operations of the British Produce Export Company of Harbin in shipping frozen and preserved meats, poultry, eggs, and game to the English market are increasing satisfactorily. The United States buys wool, hides, and furs, and supplies in return typically American products —kerosene, vehicles, and machinery. Manchuria presents many possibilities as a market, for its growing farm population requires ever-increasing amounts of foreign goods.

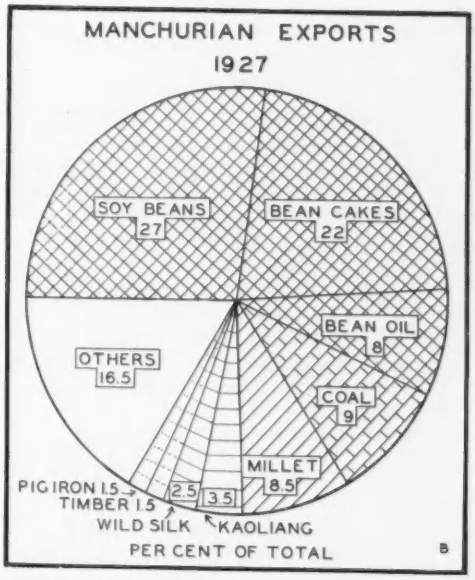

FIGURE 30.—In Manchurian exports, the soy bean and its products constitute over half the value exported.

FOREIGN RIGHTS AND INTERESTS

The history and economic development of Manchuria have been intimately linked with the question of foreign rights and interests. Manchuria is best known to the world as a source of international controversy; for in no other part of China have foreign powers secured such vital rights and sweeping concessions. Russia's interest in North Manchuria is primarily political and strategic, and consists of the forceful retention of its 50 per cent share in the ownership and management of the Chinese Eastern Railway which is a direct link in the Trans-Siberian system of communications and Siberia's outlet to the port of Vladivostok. Japan's interests in South Manchuria include the Leased Territory, the South Manchuria Railway, mining concessions, and the right to maintain railway guards. Japan regards the maintenance of these rights and the protection of her nationals and immense investments as vital to the safety and welfare of the Empire; for Japan looks to Manchuria as a strategic outpost of defense against Asiatic invasion, as an essential source of food and fertilizers for a growing population, as an indispensable source of fuels and industrial raw materials, and as a valuable market for the products of its industries. When a stable, unified, and more powerful China attempts to recover her sovereign rights surrendered to Japan and Russia, the world will be faced with grave questions of peace or war in the Far East.

The economic development of Manchuria has been made possible by the capital, enterprise, and railroads supplied by foreign nations, chiefly Japan and Russia. As a

consequence of these foreign interests and of its possession of abundant fertile lands, Manchuria has enjoyed a measure of political security and material prosperity unknown elsewhere in China. Comprising but 6 per cent of China's population, Manchuria supplied in 1927, 32 per cent of China's total trade. Its per-capita trade is 24 taels; for China it is only 4 taels per capita. Half the railway mileage of China is found in Manchuria; and it is only in Manchuria that railroad construction is being systematically prosecuted. It has the largest coal mine, the most modern iron works, and the most efficient railways in China. It produces 47 per cent of China's iron ore, 50 per cent of its pig iron, and over half of its coal. Manchuria, moreover, possesses the bulk of China's iron ore reserves and the major part of its forest resources. It is, therefore, a vital and integral part of the Chinese economy; and the ever-growing Chinese emigration assures full Chinese sovereignty over the region. The soundness of China's claim to political sovereignty is recognized by all nations, for 95 per cent of the population is Chinese. The Koreans, numbering less than half a million, are the largest foreign minority, and hostility to them is strong.

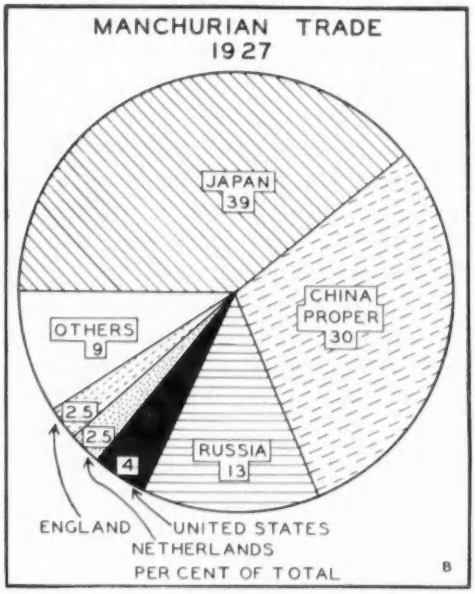

FIGURE 31.—The value of Manchuria's trade with the United States or England is relatively insignificant compared with the values of the trade with Japan, China, and even Russia.

SUMMARY

Further economic development requires the construction of new railroads to tap the unsettled areas. The development of a road system to connect farms with rail points is also a necessity. However, there is not a mile of paved or surfaced road in Manchuria outside the limits of a few cities. The region has a long distance to travel on the road of economic development before it reaches the European or American level.

Manchuria is now the frontier region, the pioneer country, and the promised land of China, but if the present rate of colonization continues, the free land will be exhausted in two decades. The area of cultivated land is now increasing at the rate of over 5 per cent per year. Settlement in the Liao Valley has already reached the saturation point. Manchuria can support on the Chinese level a maximum population of between 50 and 75 million people. It is to be hoped, however, that the increase of population by birth and immigration can be regulated so as to permit an increase in the standard of living; for it would be a misfortune if the abundant resources of Manchuria were used merely to develop another center of Chinese overpopulation. The utilization of these resources is a problem which Chinese statesmanship must solve in the future.

EXPORT WHEAT PRODUCING REGIONS

Helen M. Strong

WHEAT is the principal food crop in international trade. Export production has increased steadily and competition has become keener between the chief regions growing this cereal for foreign markets.

Although wheat will thrive under a wide range of climatic conditions, the export crop is produced almost exclusively on semi-arid and sub-humid grasslands, where large areas of fairly level topography, requisite to factory grain-growing methods, with mechanized and power agriculture, have encouraged expansion in acreage to meet the advancing demand. Wheat has thus become, in general, the most profitable cash crop on these areas. A combination of these and some other factors has conduced to overproduction and unmarketed surpluses in a number of countries.

Therefore, an estimate of present wheat-producing regions and those potentially capable of growing wheat of export quality should be of value to the producer and exporter alike.

The present important export-wheat regions are in Canada, United States, Argentina, Union of Soviet Socialist Republics, Australia, and the Danube countries. All these possess, in greater or lesser degree, uncropped land with potentialities for producing export wheat. Africa also has possibilities for export-wheat production. China and British India can enlarge their wheat acreage, but probably will be able to use practically all their production for domestic consumption, so that though they will export some wheat, they may not be expected to become export countries, as such.

In this geographic study of potential export-wheat areas, only those regions will be considered which are geographically equipped to produce wheat for the export market.

Recent Expansion in Wheat Acreage and Production

World wheat production, as a whole, has increased greatly during the last ten years. Although the World War stimulated expansion onto new acreage in some places and the temporary substitution of wheat for other crops in many farming areas, it cannot be considered as either the sole or the principal element in the steadily enlarging world wheat crop. The trend of wheat production has been generally upward for many years. It is a concomitant of the spread of the white race over virgin grasslands in the Americas, Australia, and the Union of Soviet Socialist Republics, of power applied to farm machinery, and of modern land and water transportation. In a sense, these grasslands are a discovery of this generation, as were gold in the Far West and the prairie lands in the Middle West that of earlier generations, and their exploitation is contributing a wealth of wheat to the world supply.

According to the United States Department of Agriculture, the world wheat area in 1930 was 341,800,000 acres (excluding China). This was nearly 80,000,000 acres larger than that for 1921 and about 44,000,000 acres greater than the 1909–1913

average. Production for the same countries was 3,798,000,000 bushels for the 1909–1913 average, 3,378,000,000 bushels in 1921, and 4,905,000,000 bushels in 1930.

Larger yields per acre contributed to this increasing production. In 1930 such yields were larger than in 1920 for all principal wheat-producing countries except Argentina, Chile, India, Morocco, and France, and ranged from 5 to 7 bushels per acre in Algeria and adjacent countries, to 29.9 bushels per acre in Germany (*Yearbook of Agriculture*, 1931, U. S. Department of Agriculture, pp. 590–591).

Australia, Canada, and Argentina together accounted for nearly half the increased acreage between 1920 and 1930, and the rest was divided among the United States, Yugoslavia, Hungary, Rumania, Poland, Germany, and India. To utilization of large areas of newly cultivated virgin land must be attributed most of the expansion in Australia, Canada, Argentina, and the United States, all of which are large producers of export wheat. In India the larger acreage was, for the most part, on newly irrigated land.

Obviously two elements, larger yields per acre and sowing of virgin grasslands, are to a large extent responsible for the greatly augmented world wheat crop of recent years. The latter is by far the more important, but during the past 30 years increases in acre yields have added about 448,000,000 bushels to a crop on 320,000,000 acres. In the same period, when the world wheat area increased by more than 100,000,000 acres, a yield of 14.1 bushels would be the equivalent of over 1,400,000,000 bushels.[1]

[1] *The World Wheat Outlook*, 1930, U. S. D. A., Miscellaneous Publication No. 95, pp. 19–20.

Large yields on these newly cropped areas cannot be expected to continue. Experience has shown that the first crops on virgin land usually give higher yields than the later ones. Furthermore, as wheat pushes farther out nearer to the margin of its potential producing area, climatic conditions become more uncertain, so that yields are less and fluctuate considerably from year to year.

The great export-wheat crops are being produced by exploitation of semi-arid virgin grasslands, which could not be tilled profitably until the advent of power agricultural machinery and of modern transportation. The possible area cultivated and harvested per worker in a growing season has increased, so that the dry margin of agricultural land could be farmed to advantage. Because of the rather short growing season and limited moisture supply on most of these areas, they can be plowed, planted, and harvested profitably on a large scale only by use of tractors or horses in multiple hitch, and by combines. It has been estimated that tractors can plow from 8.3 to 92.8 acres in a 10-hour day in southwestern Kansas,[2] depending on size of the plow. In Indiana, in 1929, from 1.95 acres to 4.40 acres could be plowed with horse machinery in 10 hours, compared with from 7.06 acres to 10.85 acres in the same period by tractor machinery.[3]

Invention of well-drilling machinery was another element making it possible to utilize these grasslands,

[2] Nichols, R. D. and Kifer, R. S.: *Time and Materials Used in Preparing Land and Seeding Wheat in Southwestern Kansas*, Kansas Agricultural Experiment Station and U. S. Bureau of Agricultural Economics, 1930.

[3] Holmes, C. L.: *Farm Production and Costs as Affected by Mechanical Farm Equipment*, U. S. Department of Agriculture.

where a water supply is generally available only from deep wells.

GEOGRAPHIC REQUIREMENTS FOR GROWING EXPORT WHEAT

Although wheat will grow under a wider range of climatic conditions than almost any other cereal except barley, most of the wheat of export or world market quality is raised by factory methods in comparatively restricted areas in sub-humid or semi-arid climates. This is a hard wheat high in protein, while that raised in a humid climate is for the most part soft and consumed locally. This latter kind is not exported because there is little demand for it, since the principal wheat-importing regions raise plenty of soft wheat, but require the hard, high-protein wheat to bring up the strength and quality of the local soft-wheat flour. Consequently even though large-scale production were practiced in eastern United States and similar regions, soft-wheat probably would not be exported to any considerable degree because the export demand is for hard wheat.

Factory agriculture or power farming applied to export-wheat production has established a more exacting dependence on physical conditions than existed under hand or machine raised crops produced on smaller units. Three elements in the immediate physical environment are essential to this large-scale wheat production: (1) fairly level topography; (2) a rich soil that will stand abuse for many years and careless cultivation by machinery without fertilization; and (3) dry weather adapted to cheap harvesting and later storage of the wheat without deterioration.

Therefore, large export-wheat crops in the present and future will come from countries possessing regions with these characteristics. These are the United States, Canada, Argentina, Soviet Russia (in Europe and Asia), Australia, the Danube lowlands, and parts of the continent of Africa.

Wheat will grow in cool high latitudes, maturing where the three summer months each have an average temperature of 57° F. or more, and where no frost occurs during the last two of these months. In places having lower summer temperatures wheat is a hazardous crop. Where temperatures are warm, 20 inches represent about the lower limit of yearly rainfall, as, for example, in southern Texas and British India, provided it

WHEAT ACREAGE

POTENTIAL UNCROPPED AND PRESENT AREAS
(1,000 acres)

Exporting Countries, Present and Potential	*Physically Suitable Uncropped Wheat Acreage*	*Geographically[1] Potential Acreage Uncropped[2] and Capable of Producing Wheat of Export Quality*	*1930–1931 Acreage Includes Export and Domestic Production*
Canada	37,000	22,000	25,000
United States	135,000	45,000	59,000
Argentina	96,000	35,000	21,000
U. S. S. R.	422,400	42,240	61,000
Australia	80,000	40,000	18,000
Danube Region	.....	.....	20,000
Total	770,400	184,240	204,000
Africa[3]	950,000	.....	.....

[1] Estimated reasonable possibility based on adjustment of human activities to physical environment.
[2] No allowance made for annual fallow in the crop rotation. This probably would be necessary to accumulate sufficient moisture for a crop every other year.
[3] Excluded from total because estimate is not based upon facts comparable in detail to those for other countries.

comes during the growing season or earlier, leaving the harvest period dry and sunshiny. A rainfall of even 8 or 10 inches is adequate in cooler regions of less active evaporation, like the Big Bend country of Washington, or 11 inches in southwestern Saskatchewan. In regions of warmer temperatures, less than 20 inches will produce a crop if much of the annual precipitation occurs during the cool season of the year, when evaporation is slower, as in the Mediterranean climate of Algiers or in the Union of South Africa.

PRINCIPAL FACTORS LOCATING WHEAT PRODUCTION WITHIN A PHYSICALLY POTENTIAL AREA

In general, as to use of the crop, the wheat-producing regions of the world are divided into two groups—those producing for domestic consumption, and those producing for export.

WHEAT

EXPORTING COUNTRIES *Present and Potential*	ACREAGE (*1,000 Bushels*) *1930–1931 Includes Export and Domestic Production*	ACREAGE (*1,000 Bushels*) *Geographically*[1] *Potential Export Acreage Uncropped*[2]	YIELD (*Bushels*) *1930–1931*	PRODUCTION (*1,000 Bushels*) *Estimated Export*	PRODUCTION (*1,000 Bushels*) *1930–1931 Includes Export and Domestic*	PRODUCTION (*1,000 Bushels*) *Potential Export*[3] *on Uncropped Acreage*	EXPORTS (*1,000 Bushels*) *1929–1930*
Canada	25,000	22,000	15.9	12	395,854	125,000	184,213
United States	59,000	45,000	14.4	10	850,965	300,000	153,316
Argentina	21,000	35,000	12.8	10	271,404	350,000	161,265
Union Soviet Socialist Republics	60,292	42,240	10.2	10	759,000	422,400	61,892
Australia	18,160	40,000	11.8	10	214,780	400,000	11,166[4]
Africa	9,814	.....	7.9	..	99,686	.....	55,098
Danube Region	19,936	.....	....	..	354,104	.....	.....

[1] Estimated reasonable possibility based on adjustment of human activities to physical environment.

[2] No allowance made for annual fallow in the crop rotation. This probably would be necessary to accumulate sufficient moisture for a crop every other year.

[3] Annual crop might be approximately half of this, because some of the crop land probably always would be in fallow in order to accumulate two years' moisture for one year's crop.

[4] 1928–1929.

Therefore, wheat production in cooler areas is, in general, in regions having 10 to 40 inches of precipitation annually; in the hotter portions of the world the requirement ranges from 20 to 27 inches. Thus, the arid limits for wheat in general are 10 inches in cooler areas and 20 inches in hotter regions, whereas the humid limits are, similarly, 40 inches and 70 inches, according to Doctor O. E. Baker in his "Potential Supply of Wheat" which appeared in the March, 1925, issue of ECONOMIC GEOGRAPHY. Climatic conditions exclude wheat from polar areas, deserts (except where irrigated), and humid low or middle latitudes. Since wheat can stand a great amount of heat, the factor precluding its production in tropical and subtropical regions is too high humidity rather than high temperature.

This study of present and potential wheat-producing regions is concerned chiefly with the export-wheat areas, because no large increase in acreage is probable where wheat is grown largely for domestic sale or local use.

Wheat in the areas producing for domestic consumption (eastern United States, France, Germany, and some other countries) is grown in rotation with other crops, and there is slight opportunity for increased acreage there, except at the expense of some other crop.

On some of the more humid lands adapted to wheat, where precipitation and temperature conditions are

much the same from year to year, other crops, such as cotton or corn, bring a larger return. Since these crops can be grown profitably only under the more favorable climatic conditions, the wheat region, with this cereal as the dominant crop, has migrated to the climatic margin of its physically suitable area, where conditions are too severe or too uncertain for many other crops, but favorable for the hard varieties of wheat required in export trade.

CANADA

Canadian wheat acreage has expanded greatly during the last quarter of a century, increasing from less than 7,000,000 acres in 1908 to 11,000,000 acres in 1911 and to 23,000,000 acres by 1921. In 1930 it was almost 25,000,000 acres (*Canada Yearbook*, 1931, p. 230), an increase of more than 15,000,000 acres in 20 years and nearly the equivalent of the entire Australian wheat acreage for 1929.

FIGURE 1.—On an Alberta, Canada, wheat farm, with tractor and three drills seeding one hundred fifty acres of wheat per day. (Courtesy of Caterpillar Tractor Company.)

PRESENT AND POTENTIAL ACREAGE, YIELD, AND PRODUCTION, IN PRINCIPAL COUNTRIES PRODUCING EXPORT WHEAT

Six vast grassland regions are today producing practically all the world's export wheat. These are Canada, United States, Argentina, Australia, Soviet Russia, and the Danube lowlands. Indian wheat, though produced almost wholly for domestic consumption, is frequently a factor in the export market. When the price of wheat is high, or when there is a crop larger than usual in India, some of it may be exported, and in such cases this grain frequently influences the world price of wheat.

The Prairie Provinces contain 90 per cent of the Canadian wheat acreage, and the crop is raised almost entirely for export. In eastern Canada wheat is grown in rotation with other crops, mostly for local consumption.

The largest increase in wheat acreage in the Prairie Provinces during recent years has been on the prairies and "park lands" of Alberta. Recently wheat production has been developing in the Peace River country over the provincial border in British Columbia.

Canadian agriculturists have estimated the chernozem belt in the Prairie Provinces to comprise 52,000,000 acres, and the brown-earth possibly 35,000,000 acres or more,

including present cultivated land—a total of 87,000,000 acres physically suited to wheat.

Because of low rainfall, considerable portions of the land on the arid margin lie fallow each year to accumulate the two years' moisture supply necessary for one year's crop. Consequently, the area of improved land in the Prairie Provinces, about 50,000,000 acres (*Canada Yearbook*, 1929, p. 272), rather than that of land in crops, is subtracted from the entire amount of potential wheat land to obtain an estimate of the uncropped land capable of producing export wheat. This would leave 37,000,000 acres of uncropped potential wheat land.

In 1927 wheat occupied about 60 per cent of the acreage in field crops in the Prairie Provinces, though all such land is physically adapted to wheat production. No doubt, other things being equal, wheat will occupy no smaller proportion of the uncropped land, because most other crops cannot thrive under the more severe physical conditions in these marginal lands. Sixty per cent of the virgin land in wheat would amount to about 22,000,000 acres, some of which would necessarily lie fallow each year.

Yields in the Prairie Provinces over the 10-year period 1918–1927 averaged from 15 to 16.4 bushels per acre (*Canada Yearbook*, 1929, p. 237). Probably the marginal lands would not afford so high a yield, possibly not more than 12 bushels an acre. At this rate the uncropped wheat land might produce a crop of 125,000,000 bushels.

The great triangular area of Canadian grasslands is hemmed in on the northeast by thick spruce-hemlock-aspen forests, and on the west by the Rockies. On the south it touches the United States boundary. Few streams dissect the comparatively level surface, which lends itself well to use of power machinery so essential to large-scale production.

Rainfall averages 12 to 18 inches annually, and two-thirds of it occurs during the growing season. Because of the favorable seasonal distribution and the comparatively low evaporation, this amount is fairly adequate.

The growing season is shorter than on the Montana-Dakota wheat lands, but about 12 to 18 hours of sunshine daily during this period help to compensate for fewer frost-free days.

Chinook winds, characteristic of the western part of the Prairie Provinces, exercise a favorable influence by clearing the ground of snow and warming it earlier than usually occurs where areas in the same latitude are not subject to these winds. As these winds are forced downward and warmed by compression in their descent, they also evaporate some of the rather scanty moisture supply. Their influence is felt even to Saskatoon in Saskatchewan.

It may be said here that all distances in this study, on water as well as land, will be given in statute miles, so that land and water distances may be added or compared if desirable. The western and northwestern portions of the Prairie Province wheat lands are only about 500 miles from Prince Rupert and Vancouver, which is a short rail haul over the Rockies, as compared with 1,215 miles from Edmonton to the head of the Lakes and a total to Montreal by rail and water of nearly 2,500 miles. From Montreal to Liverpool the distance is about 3,200 miles, and from Edmonton to Liverpool more than 5,500 miles. This proximity to Pacific

ports is an advantage in shipping to the Orient, and to Europe via the Panama Canal.

The Hudson Bay Railway to Churchill on Hudson Bay is completed, but not in operation, and wheat probably will not be shipped over this route earlier than the fall of 1932. Port works at Churchill probably will be ready for general freight business by the spring of 1932, two trial shipments having left Churchill in September, 1931. The distance from Edmonton, Alberta, to Churchill, via Battleford, is 1,145 miles, and from Churchill to Liverpool, via Hudson Strait, about 3,500 miles, a total of 4,645 miles by this route from Edmonton to Liverpool.

Practically all eastbound Canadian export wheat goes to Port Arthur-Fort Williams at the head of the Lakes. In 1928 nearly 400,000,000 bushels of grain were shipped from these ports,[4] comprising 75 per cent of the wheat and 54 per cent of all grain moving from ports on Lakes Superior and Michigan by water.[4]

Elevator capacity at Port Arthur-Fort Williams, 87,000,000 bushels,[4] so far exceeds the receiving capacity at Montreal and Quebec that a large share of Canadian grain has in the past necessarily moved through American ports; in addition, the port of New York is open all the year, while that at Montreal is icebound for four months, usually from December 15 to April 24. Both these conditions have tended to direct a great deal of wheat via Buffalo to New York.

The new Welland Canal was officially opened April 12, 1931, but is not yet (March, 1932) entirely completed. It provides for draft of 30 feet over the miter sills at extreme low stages in the Lakes, and will permit passage of large vessels. Until canals along the St. Lawrence are deepened, grain will be transshipped to smaller boats at Prescott, below Lake Ontario on the St. Lawrence River, and carried thence to Montreal. This may divert considerable grain traffic from Buffalo, for the distance to Liverpool via Montreal is nearly 500 miles shorter than that by way of New York.

[4] *Transportation on the Great Lakes* (Nov., 1930), prepared by Board of Engineers for Rivers and Harbors, War Department, and Bureau of Operations, U. S. Shipping Board, pp. 87, 141, 142.

UNITED STATES

Between 1910 and 1930 wheat acreage in the United States increased from about 45,000,000 to 59,000,000 acres, but in 1919 there was a record area in wheat, more than 75,000,000 acres (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agriculture, p. 583). This included land that had been in wheat, some ordinarily in other crops or in pasture, and much virgin grassland and range in the West, newly brought under the plow. Most of the land temporarily in wheat in the East has reverted to its former use.

The principal expansion of wheat acreage in the United States has been on the drier sub-humid or semi-arid grasslands in the West producing hard wheat for the export market. Wheat has pushed steadily forward onto the belt of brown soils which extends from Montana through western Nebraska, Kansas, and Oklahoma, into Texas. Fairly level areas in these regions of low rainfall invite use of power machinery. It is believed that 5,000 acres is the optimum size for a wheat farm in this region. Of this total acreage, 1,200 to 1,500 acres would be in wheat and

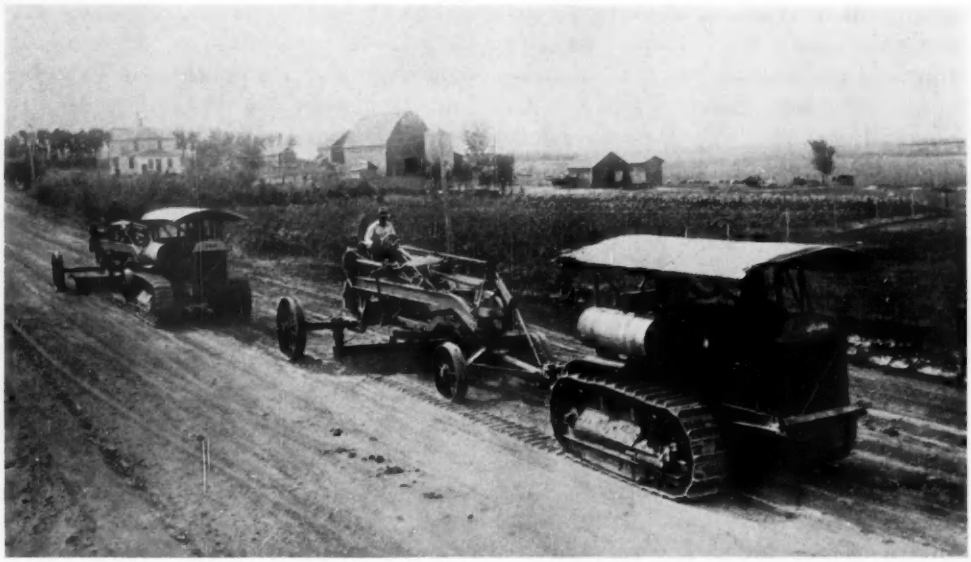

FIGURE 2.—A South Dakota farmstead and wheat country landscape. (Courtesy of Caterpillar Tractor Co.)

a similar area in fallow, accumulating moisture for the next year's crop. The rest would be, on the average, breaks and scab land. When seed is sown by machinery, thickness of stand may be regulated according to available moisture supply. Labor requirements are small in this kind of farming, for with power-driven machinery two men can plow, seed, and harvest 1,000 or 2,000 acres in a season.

Precipitation along the arid margin of this belt ranges from about 12 inches in Montana to 20 inches in Texas. Higher temperatures, and therefore a higher rate of evaporation, in the South give less effective rainfall than in the North, so that in southwestern Texas almost no wheat is grown under less than 20 inches of rainfall. In central Washington, however, 10 inches produce a crop, and if the price of wheat should go high enough, wheat production might move to the area of 8-inch precipitation.[5]

[5] Baker, O. E. *Social Science Encyclopedia.*

Export wheat acreage may expand yet farther in this entire western region. Conditions here are not favorable for a variety of crops; so, doubtless, the tendency will be to raise grain or cattle.

It has been estimated that there remain uncropped and suitable for crops in the United States about 75,000,000 acres in the black-earth (chernozem) and 60,000,000 acres in the brown-earth belt, extending southward from Montana and the western Dakotas through Nebraska and western Kansas to Texas. This makes 135,000,000 acres in the West available for crops, excluding rough and hilly land and poorer soil.[5]

Not all this land would be in wheat. About 12 per cent of the entire crop area reported for the 1925 agricultural census was in wheat in States possessing black and brown earth soils. However, the proportion may become larger if it should be profitable to cultivate land nearer the marginal limits of the wheat area. If one-third of the uncropped black

FIGURE 3.—A combine harvester and thresher, drawn by twenty-six horses and mules, operating in the Oregon wheat country of the Pacific Northwest.

and brown earths of the United States were to be in wheat, the area would amount to 45,000,000 acres. But part of this one-half or more always would be in summer fallow, to accumulate sufficient moisture for a biennial crop; therefore, in any one year, at 10 bushels per acre possibly about 300,000,000 bushels of wheat would come from this land, or approximately one-third of the 1930–1931 wheat crop in the United States, which totaled 850,965,000 bushels (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agriculture, p. 590).

Pasture land and land in other crops in the East, capable of producing wheat, may amount to over 100,000,000 acres, but the wheat here is not a hard variety of the type preferred for export. Consequently, even though large-scale production were instituted, this wheat would not compete in export-wheat markets of the world, and the export-wheat crop would continue to be derived from the sub-humid and semi-arid lands of the West.

"Grain from the surplus-producing sections of the United States now moves to seaboard for export and for domestic consumption by way of many routes, some of which are keenly competitive, so far as grain destined to the western European consuming pool is concerned, especially. There is less competition for movements to other portions of the world, particularly to the Orient which consumes increasing quantities of grain. . . . Notwithstanding the large consumption of grain in the United States, there is every year a large surplus which must be disposed of in foreign markets. The center of this producing territory is situated considerably more than 1,000 miles from the sea, and the cost of getting grain from the farm to the ship at our ocean ports is a very important factor in fixing not only the profits of the farmer, but our ability as a nation to compete successfully with other countries whose grain-producing areas are situated nearer the seaboard. The sensitiveness of grain to transportation costs is well indicated by figures given later in this report, showing the enormous quantities naturally gravitating to the lake route, which is the cheapest from a very large section of the country. Not all the grain seeking the lake route, however, is for export; large quantities are for domestic consumption, including milling at eastern and seaboard points.

"It is well known that a saving of

as little as one-fourth cent per bushel will serve to divert substantial movements of grain. Indeed, the situation is such that the grain shipper must constantly be alert not only with respect to the actual rates over the various routes, but also the conditions affecting the promptness of movement, the situation at the terminal elevators, etc. Grain is very desirable deadweight cargo for liners, and it has been generally recognized that the interests of shipping render it undesirable to include grain rates among those rigidly fixed by conference, because of the fact that vessels must be left free to compete for grain which they need for loading. The situation is such that the water rates, both lake and ocean, are constantly changing and these changes affect the through transportation costs, regardless of the fact that the rail portions thereof are fixed. The actual quantities of grain moving to seaboard from year to year over each of the routes vary widely.

. . . . . .

"Grain from the Dakotas and Minnesota, as well as from the Canadian Provinces, moves chiefly to the Great Lakes, with a very small portion passing through Gulf ports.

. . . . . .

"Grain for export from the northern tier of states moves chiefly to Duluth-Superior, while that from Illinois, Indiana, Iowa, and portions of Missouri, Kansas, South Dakota, Minnesota, and Wisconsin moves to Chicago and Milwaukee. Some of the Illinois and Indiana grain moves to Toledo and other Lake Erie ports. Not much change has occurred in recent years in the movement from the more northerly wheat states with the exception of the diversion of a small portion to Gulf ports. The influence of the Mississippi-Warrior Barge Line has been instrumental in a rather pronounced movement of grain to Gulf ports from Missouri River territory and from Kansas and Nebraska. The diversion has occurred principally in the grain which formerly moved all-rail to the Atlantic seaboard and has not affected that produced in the territory which makes the large contribution to the Great Lakes system."[5]

From Buffalo shipments to the seaboard are by the New York Barge Canal and by rail. In 1928 more than 38,000,000 bushels of grain, largely wheat, passed over the former route, and somewhat less than 18,000,000 bushels over the latter.[6]

Although the distance from New Orleans to Liverpool is 5,313 miles, as compared with 3,613 miles from New York to Liverpool, nevertheless a large export-wheat area, especially the western Kansas section, is shipping via the shorter rail route of about 600 miles or less to New Orleans and Gulf ports, instead of using the longer one to the Great Lakes. Good ocean rates are available along the Gulf because grain is sought at these ports as deadweight by vessels carrying cotton to Europe. Because of its bulk in proportion to weight, cotton is not suitable for a full load, and a heavy cargo like grain balances the load. Consequently vessels receiving a relatively high freight rate for cotton offer comparatively low rates on grain.[6]

ARGENTINA

During the past ten years wheat acreage in Argentina has expanded from about 16,000,000 to more than

[6] *Transportation on the Great Lakes*, pp. 86–87, 88–89, 135.

21,000,000 acres (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agriculture, p. 591). Climate, soil, and land surface favor a yet larger increase.

Production of export wheat has expanded until now it extends from central Entre Rios across Santa Fé and southeastern Córdoba, thence across eastern La Pampa and western Buenos Aires to Bahía Blanca and beyond. This is a region devoted principally to wheat. Of the 1929–1930 area amounting to more than 19,000,000 acres, nearly 14,000,000 acres were in western Buenos Aires and in Córdoba, according to the United States Department of Agriculture.

There the loess-like soil is fine, deep, and fertile, spreading over a vast level land, almost uncut by stream valleys; rain is sufficient during the growing season for wheat, and the ripening and harvesting season is generally dry and sunny. The larger part of this area now in wheat is situated within 200 miles of the great wheat shipping ports of Rosario, Buenos Aires, and Bahía Blanca, where favorable freight rates are generally to be had for the haul of more than 7,000 miles to Liverpool or to other ports of northwest Europe. Rainfall here varies from 16 to 36 inches annually, the occasional droughts being reflected in wheat exports.

It is rather difficult to know the area of uncropped land capable of profitably producing export wheat. Doctor Clarence F. Jones in his book entitled "South America" has estimated that there are in Argentina 225,000,000 acres physically adapted to wheat culture. All of this cannot profitably produce export wheat. The best wheat soils, which happen also to include regions situated most conveniently for export purposes, already are planted to wheat.

Wheat can be grown in northern Argentina in La Rioja, Catamarca, Salta, Jujuy, and Tucumán. The growing season there has an average temperature of 75° F. or more. The average annual precipitation in La Rioja and Catamarca is only about 11 inches, and more in the other three provinces. Rain occurs here in the growing season, which is followed by a dry, sunny, ripening and harvesting season. Insufficient rainfall on the western and too much on the eastern margin limits this wheat-growing area.

Wheat is raised to some extent in Mendoza, San Luís, and Neuquen, west of the present large wheat growing area; but low precipitation, mostly less than 15 inches, renders crops dependent on irrigation or dry-farming methods.

Temperatures would permit wheat production from the Rio Negro as far south as the Straits of Magellan, but, in general, too little rainfall, rough topography, and stony or otherwise unsuitable soil are not conducive to its production there.

Wheat could be extended eastward in Buenos Aires Province into the present corn and flax belt, should it become economically more profitable than these crops. Farther eastward, among the cattle estancias, both temperature and rainfall are suited to wheat production, but the water table is close to the surface except in scattered areas of somewhat higher elevation which are limited in extent. The surface gradient is low; consequently extensive drainage works would be needed to prepare the land for wheat cultivation.

Probably very little of the land to the north, east, south, and west of

the Pampa would lend itself to the production of wheat for export. Therefore, it may safely be assumed that only the Pampa itself and immediately adjacent areas are potential export-wheat territory.

The combined area of the provinces of Buenos Aires, Santa Fé, Córdoba, and La Pampa, within which the Pampa lies, is about 290,000 square miles (185,600,000 acres).

A correlation of climate, soil, and topography in relation to wheat production would seem to indicate that the best wheat land of Argentina is now in wheat. The geographic implications as to utilization of the land for export wheat would seem to favor development of the future export-wheat region on the Pampa and adjacent areas. Essentially all the present and potential export-wheat territory is in the four previously named provinces. In addition, it would include possibly the southern two-thirds of Santa Fé, the southeastern two-thirds of Córdoba, southeastern half of La Pampa, and all except the eastern quarter of Buenos Aires. Taken together, this amounts to approximately 200,000 square miles (128,000,000 acres) of potential export-wheat land.

Climatically and topographically nearly all this land is suited to wheat production, but portions doubtless are too sandy or require drainage. On this basis possibly one-fourth or less would be eliminated, leaving 96,000,000 acres physically adapted to wheat production.

If export wheat culture expands over much of this area, it probably would continue to be the dominant crop, because land surface and location in relation to tidewater are so favorable. In 1925–1926 the area sown to cereals in these four provinces was 31,154,065 acres, of which 19,206,795 acres were in wheat. In addition, about 5,000,000 acres were planted to other crops.[7] Subtracting this 36,000,000 acres in crops from the total cultivable land would leave 60,000,000 acres of potential export-wheat land. Granting the same ratio as today between wheat and other crops, a little better than 50 per cent, would furnish about 35,000,000 acres geographically adapted to export-wheat production.

FIGURE 4.—A level Argentine Landscape. Wheat is being sown. (Courtesy of Central Argentine Railway.)

Yield per acre in Argentina was 12.8 bushels in 1930, which was 3.7 bushels more than in 1910 and 1.5 bushels less than in 1920 (*Yearbook of Agriculture*, 1931, U. S. Department of Agriculture, p. 591). Cropping of new land and seed selection has tended to increase yields, but drought or too cold or too hot weather causes yields to vary greatly from year to year. Rainfall in December, during the harvest season for wheat, has varied from 0.15 to 7 inches on the Pampa; and annual rainfall from year to year, as well as that for the same months in different years, fluctuates greatly.

[7] *Anuario de Estadística Agro-Pecuaria 1925–1926*, Sec. B, pp. 28, 33, 37.

Temperatures also differ from year to year, but the records indicate less variation in temperature than for precipitation. At 10 bushels an acre the crops on the estimated export-wheat land might amount to 350,000,000 bushels.

Transportation is well developed on the Pampa, nearly all the region being within 25 miles of a railroad.

The Argentine export-wheat lands are especially well located in relation to ocean ports, the most distant parts of the estimated export area being little more than 400 miles from tidewater. However, it is 6,900 miles from Buenos Aires to Liverpool, as compared with 4,989 miles from Odessa to the latter port. No doubt adjacent South American countries and Europe will continue to be markets for Argentine wheat.

UNION OF SOVIET SOCIALIST REPUBLICS (U. S. S. R.)

The soils of the great wheat belt of the U. S. S. R. are in reality continuous from the mountains of western Rumania to Lake Baikal, a distance of approximately 4,000 miles, more than twice the combined length of the wheat belts in western United States and Canada. In width this Russian belt varies from less than 200 to more than 600 miles, an enormous area of chernozem (black earth), and chestnut-brown soils. A planimeter measure made on a fairly accurate map of these soils gives 754,000 square miles for the chernozem and 581,000 square miles for the chestnut-brown soils,[8] making in the U. S. S. R., including Europe and Asia, a total potential wheat area of 1,335,000 square miles, making no allowance for surface or soil conditions. Even though this is a vast area, it is not so large in proportion to others as might be assumed when looking at the Mercator World Map so frequently used.

Wheat was sown on only about 126,000 square miles (80,000,000 acres) in the U. S. S. R. in 1929, only a fraction of the black and brown earth areas there. In the United States wheat was sown on 57,089,000 acres (89,000 square miles) according to the United States Department of Agriculture in 1931, and on the average is dominant on 154,778 square miles of black and brown earths, or 29 per cent of these soils. This includes a small area in southwestern Nebraska and northwestern Kansas west of the general black-earth or chernozem boundary, where wheat acreage is large, according to Doctor Marbut.

Although the wheat soils of Soviet Russia are divided nearly equally between Europe and Asia, the larger part of the black earth is in Europe. A planimeter measure made by the writer on Dr. Marbut's map shows about 470,000 square miles in Europe, and 380,000 square miles in Asia, which means that the larger area of black earth is relatively accessible to the Black Sea.

The very vastness of this area and fineness of the fairly level black soil have in the past tended to make complete commercial utilization difficult. On it roads became almost impassable in wet weather, entirely preventing movement of heavy loads, while even light loads could move neither far nor fast. Thus wheat could not be shipped long distances to river or Black Sea ports, neither could a labor supply adequate to plant, cultivate, and harvest all this area be shifted quickly from place to

[8] Marbut, C. F. *Russia, the United States and Wheat*, Geog. Rev., 1931, Vol. XXI, No. 1, p. 7.

place as agricultural activities required. Except on large estates, most of which were comparatively near the Black Sea, strip farming prevailed, peasants tilling their small plots by hand.

Because of these and other limitations to expansion of crop land in Russia, there yet remain in the U. S. S. R., both in Europe and Asia, considerable areas of virgin grasslands adapted to wheat cultivation. East of Rostov in the territory of the northern Caucasus there are, no doubt, nearly 2,500,000 acres (3,900 square miles) of virgin black-earth (chernozem) soils, about 300,000 acres of which were put into State farms in 1929 and 1930. Owing to absence of surveys, the exact amount of unoccupied available wheat land in Soviet Russia in Asia is not known, but indications are that it is larger rather than smaller than the estimate. Several large, smooth, plateau areas, practically unoccupied, according to reliable reports, have been revealed by recent exploration. In some cases these areas cover rather more than 150 miles in length and 50 miles in width according to Doctor Marbut. Settlement there was postponed, as on the American prairies, because a water supply was available only from deep wells, and the peasants lacked capital and tools to drill them.

These Russian wheat lands are, for the most part, in the same latitude as those of the Prairie Provinces of Canada and, likewise, have daily long hours of summer sunshine. In elevation they are lower than those in Canada, all except the eastern part, near Irkutsk, being 600 feet or less above sea level.

The climate is continental, characterized by extremes of heat and cold between summer and winter temperatures and during the same season, and by relatively low and somewhat irregular rainfall. Between Odessa and Irkutsk annual precipitation varies from 14 to 19 inches, but as evaporation is not excessive, most of the moisture is effective for plant growth.

A better understanding of conditions affecting development of the Russian wheat area may be gained by comparison with those in the United States. Pioneers in central Ohio have told of the bountiful wheat harvests in Pickaway County, which were used for fuel until the Ohio Canal opened the area to domestic markets in the East and export markets in Europe. While settlers throughout the Middle West and on the Great Plains experienced many difficulties, not until railroads were extended throughout the region were its resources adequately utilized and developed. The Russian wheat belt, if laid down on the United States, would extend from New York to California and out into the Pacific Ocean. Manifestly, complete utilization of such a vast area is dependent on coordination of efficient water transportation, railroads, and hard roads.

The Volga, Dneiper, and a few other streams have carried much wheat, but without hard roads as feeders often a strip not more than 20 miles wide on each bank would profitably be tributary to river traffic. Furthermore, the Volga, Russia's great water highway, flows into the landlocked Caspian Sea, and consequently its burden of export wheat has gone upstream to connect with canals leading westward toward the Baltic.

Railroad construction has a large

task ahead before adequate railroad transportation is available to the black and brown earth stretches of the U. S. S. R. At present there are 35,000 miles of railroad in European Soviet Russia, and 10,000 miles in the Asiatic part of that country. The former mileage serves about 2,000,000 square miles, and the latter 6,000,000 square miles of territory.

FIGURE 5.—Use of machinery, both horse and power operated, is increasing on the collectivized farms of the U. S. S. R. Large areas of level fertile soil are well adapted to its use. (Courtesy of Soviet Photo Agency.)

The United States has 260,000 miles of railroad for about 3,000,000 square miles of area. In other words, the U. S. S. R. has approximately one-sixth the railroad mileage of the United States and three times the area.

The location of the Russian wheat lands with reference to tidewater is also an element in their development. The extreme western part of Siberia is about 1,200 miles from Black Sea ports, but the black and brown earths between this point and Irkutsk on Lake Baikal are considerably more than 1,200 miles from both the Black Sea and the Pacific Ocean. Irkutsk is more than 2,500 miles from the Black Sea, and at least 1,500 miles from Vladivostok. Obviously a very long rail haul, longer than that for any present export-wheat producing region, confronts grain produced in central or western Siberia. In this connection, however, it is of interest that the Soviet government has scheduled construction of about 1,500 miles of railroad, connecting with the Trans-Siberian and Trans-Caspian Railroads. However, even the contemplated double-tracking of the Trans-Siberian Railroad will bring central and western Siberia no nearer tide-water.

Before the World War most of the Russian export wheat came from southern and south-central European Russia, within 600 miles of the Black Sea.

Of the entire area of chernozem and brown earth, about 20 per cent, or probably more, is doubtless too rough, stony, or sandy for wheat production; but, in order not to overestimate, say 25 per cent is unsuited to wheat culture, there would yet remain 1,000,000 square miles upon which wheat might be grown.

The wheat soils of Soviet Russia will be used for other crops as well as wheat. Already such essential crops as sugar beets, hemp, soy beans, and fruit occupy portions of the Ukraine, parts of the north Caucasus region, and the Black Sea coast in the Crimea, where rainfall is higher and somewhat more dependable than in the central part of the black-earth area.

The total sown area in Soviet Russia in 1930 amounted to 492,601 square miles (315,264,640 acres),[9] of which 134,053 square miles (85,794,000 acres), or about 30 per cent, was in wheat. In 1931 the area in wheat has been reported to be 92,554,000 acres (144,615 square miles) of a total sown area of about 226,000,000 acres,

[9] *Agricultural Statistics of the Union of Socialist Soviet Republics* (Moscow, 1930), p. 13.

according to the United States Department of Agriculture. Not all the sown area is on soils suitable for wheat, though as much as two-thirds or three-fourths of it may be so located, possibly 340,000 square miles. Subtracting this from the estimated 1,000,000 square miles of potential wheat area would leave 660,000 square miles of black and brown earth not sown.

This estimated uncropped area would be distributed among other crops as well as wheat, probably according to much the same economic law which has functioned in crop distribution on wheat land in other regions. Crops having narrower and more exacting climatic limitations than wheat tend to occupy the better wheat soil, leaving the physically marginal portions to wheat. With the development of transportation in Soviet Russia, the principal export-wheat areas may recede eastward beyond Rostov, or even beyond the Urals, much as the wheat area of the United States receded when the rail net there extended westward. The distance from which this wheat may be shipped to tidewater would depend upon a number of factors, important among which are the export price of the grain, the cost of production, and the cost of transportation.

Export wheat produced east of the Urals may, in the future, have an important rail or motor outlet into China, or possibly even toward Afghanistan and India. The Turkestan-Siberian (Turk-Sib) Railway, and branches of the Trans-Caspian and Trans-Siberian railways skirt the borders of these countries, and when transportation is developed across the border, wheat may find an export market there.

Only a portion of the Soviet wheat land would be used for export wheat, the area to be decided largely by the balance between domestic and export demand, other things being equal. The steadily growing Soviet population probably will consume larger and larger quantities of wheat. On the other hand, Soviet land is peculiarly adapted to mechanized wheat production, by virtue of the vast uninterrupted areas of level black and brown earths. These geographic factors render wheat a profitable and logical export commodity. Consequently, there may be a strong incentive to produce as much export wheat as can be sold. The desire to do this may influence Soviet Russia to cut the price as low as possible, in order to gain or retain export markets.

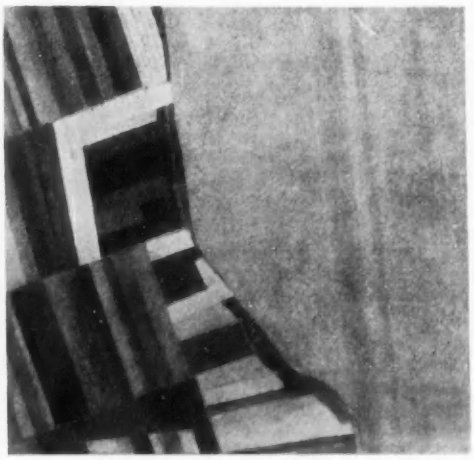

FIGURE 6.—Airplane view of small strips of land, independently tilled by individuals, and those merged into the vast expanse of the collective farm. (Courtesy of Soviet Photo Agency.)

The United States has exported in recent years about 20 per cent of its wheat crop. In Soviet Russia various conditions may favor a greater emphasis upon wheat export than in the United States. If this be so, the Soviet Union may export a larger proportion of their wheat crop than

does the United States, and there may thus be in the U. S. S. R. a larger percentage of the land in export wheat unless the Russian population should increase so as to require most of the wheat grown.

Thirty per cent of the 660,000 square miles assumed as wheat land would make 198,000 square miles. Should one-third of this be in export wheat, the area in export wheat alone would cover about 66,000 square miles, or 42,240,000 acres—about four-fifths of the total sown to wheat in the United States.

Because much of this land is climatically marginal in character, probably 10 bushels an acre would be a fair yield. This would produce a crop of 422,000,000 bushels of export quality. However, necessary rotation between crop and fallow would further reduce the annual crop probably by one-half.

Government grain farms in the U. S. S. R. already organized or definitely planned cover about 25,000,000 acres, partly in Europe and partly in Asiatic Russia, and located on both chernozems and brown earths.

Considering the amount of wheat which the world can consume, and the comparative advantages of Soviet Russia and competing countries for producing wheat of export quality, it is doubtful if Soviet Russia can profitably expand its export wheat acreage to the physical limit.

THE DANUBE COUNTRIES

Much land in these countries has been cropped for centuries.

Hungary

Hungary is predominantly agricultural, 93.8 per cent of its land being classified as productive. Of this, in 1927, 60.3 per cent was under the plow, 18.1 per cent in meadows and pastures, and 11.7 per cent in forests.[10] It is a country devoted to field-crop production and the livestock industry, and practically all the arable land is cultivated.

Following the World War land reforms were initiated which increased the proportion of total plow land held in small plots from 55.5 per cent in 1913 to 66.7 per cent in 1926.[10] In 1920 about 5,830,000 acres, or one-third of the total plow land, was in holdings of more than 1,400 acres, and only about one-third of the 2,118,145 active farmers and farm laborers owned or operated holdings of more than 142.2 acres each.[10]

Since the land reform, production of wheat in the Hungary of present boundaries has exceeded that before the World War. However, the capricious rainfall and devastating dry winds that frequently sweep over the great plains at plowing time in early spring, and intermittently during the growing season, occasionally curtail the crops.

Cereal production is the chief occupation of Hungarian farmers, and wheat is the chief crop. In 1930 it amounted to about 73,000,000 bushels, of which 31,415,000 bushels were exported. The area in wheat was about 4,000,000 acres (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agriculture, p. 590). Probably about half the wheat exported from Hungary is produced on the large estates and middle-size holdings, where the quality of grain is more uniform and of higher grade than that on the small peasant holdings. Most of the grain is exported as flour to

[10] All statistics refer to land within present boundaries. Michael, Louis G. *Agricultural Survey of Europe, Hungary*, U. S. Department of Agriculture Tech. Bull. 160, 1930, p. 7, 11, 12.

Austria, Czechoslovakia, and other countries in northwest Europe. In competing with countries to the southeast, Hungary has the advantage of lower cost of agricultural production, because her agricultural methods are more progressive and yields per acre average higher.[11]

Rumania

The amount of cultivated land in the area covered by Rumania of present-day boundaries has remained remarkably constant for centuries, but wheat acreage there is less than before the war. The average acreage for 1909–1910 to 1913–1914 was about 9,500,000 acres, and in 1930–1931 it was 7,550,000 acres. After the war the yield declined, then increased again, and in 1930–1931 it was 17.3 bushels an acre, as compared with 16.7 bushels in 1909–1910 to 1913–1914. The crop for 1930–1931 was 130,770,000 bushels, and for 1909–1910 to 1913–1914 averaged 158,670,000 bushels (*Yearbook of Agriculture*, 1931, U. S. Department of Agriculture, p. 590).

Wheat production has at no time equaled that before the World War. Most of the land now is in small holdings and is not cultivated as efficiently and scientifically as it was in large estates. Little attention is paid to seed selection, and hand methods are used, including broadcasting the seed instead of drilling.

Another element tending to a smaller wheat crop is the fact that peasants, when unrestricted in crop selection, have planted whatever crops they chose, instead of putting many acres into wheat.

In Bessarabia, with small holdings the yield was 4 bushels less per acre than when the land was in large estates, and in Old Rumania, it averaged 2.4 bushels less.[12]

Before the war Rumanian wheat was an important competitor of American grain in European markets, and Rumania exported 35 per cent of its crop of 159,000,000 bushels. In 1928–1929, the Rumania of today, with twice the area of plowed land as compared with Old Rumania, and more than twice the total area, produced less wheat, the crop being about 100,000,000 bushels, and exported only about 1,600,000 bushels (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agr., pp. 590, 599).

Rumania is endowed with physical resources of area, soil, climate, and location with reference to transportation and markets favoring a larger wheat crop.

The annual rainfall is about 25 inches and is well distributed throughout the growing season, and the harvest time is dry and sunshiny. Droughts sometimes occur, cutting down the crop. There is much level, fertile land, and the areas that can be seeded to field crops are about twice as great as the areas that formerly produced the great export wheat crops of Old Rumania. In this connection it must be remembered that Rumania now possesses wheat land formerly belonging to and tilled by Bulgaria, Russia, and Austria-Hungary.

Rumanian wheat lands are accessible to the Black Sea by a short rail or water haul, and thence by sea to markets of northwest Europe. Likewise, grain or flour may be shipped

[11] Michael, Louis G.: *Agricultural Survey of Europe, Hungary*, U. S. Dept. of Agriculture Tech. Bull. No. 160, 1930, pp. 3, 7, 10–25.

[12] Michael, Louis G.: *Agricultural Survey of Europe, The Danube Basin, Part 2*, U. S. Department of Agriculture Tech. Bull. 126, pp. 31–33.

up the Danube, though the new political boundaries and tariffs largely obstruct this movement which had become well established before the World War.

However, it is probable that the general trend in agriculture in Greater Rumania will be away from large-scale cereal production, and production of wheat for export. The larger number of livestock being raised on farms will tend to absorb cereals for feed, and the larger consumption of wheat as well as meat in Rumania since the war will contribute to a smaller surplus of wheat for export.

Yugoslavia

Yugoslavia is a country of mountains which come down to the sea along the Adriatic coast, and which are bordered on the northeast by the fertile valley plains of the Danube and Tisza rivers. The important valleys of the Morava, Drava, and Sava rivers are tributary to the broad Danube-Tisza lowland, which in former times was embraced within the areas of Croatia, Slavonia, and Voivodina. These lowlands comprise about one-third the area of the country.

From the mountain area the Kardar Valley leads southward, through what was Old Serbia, and continues on through Greek territory to Saloniki. Besides these larger valleys which connect with areas outside the mountains, there are within the mountains many small, relatively isolated valleys, especially in Bosnia and Montenegro. The rainfall within the mountainous sections is higher and more regular than on the lowlands. Communication from place to place within the highlands is frequently difficult. These geographic conditions influence agriculture—as, in fact, all human activities within the Kingdom of Yugoslavia.

The result has been that, in general, commercial agriculture is practiced on the lowlands of the northeast, where the surplus wheat crop is produced, and people of the highlands are engaged principally in subsistence agriculture.

During the war the highlands of northwestern Yugoslavia were cut off from their usual source of wheat supply, so raised the cereal to provide for local consumption. This has been continued and accounts, in large measure, for the increased production in Yugoslavia. Throughout the rest of the highlands wheat is raised for local food and feed.

Yugoslavia is approximately the same in area as the state of Oregon, or of Alabama and Mississippi combined. The broad valley lowlands in the northeast were before the war divided for the most part into large estates. After the land reform following the war these were leased to peasant cultivators, who continued the same agricultural practices as they had employed before when working for the landed nobles.

Conditions of climate, soil, and topography in the northeastern surplus-producing areas are similar to those in adjacent Hungary and Rumania. The soil is fertile, topography relatively level, and temperatures similar to those in Hungary, or about the same as in Lancaster, Pennsylvania. Precipitation is, however, much less than in eastern Pennsylvania, and comparable with that in portions of Nebraska, averaging about 23 inches annually. Precipitation differs in amount from season to season, and droughts occasionally occur.

Acreage, production, and yield of

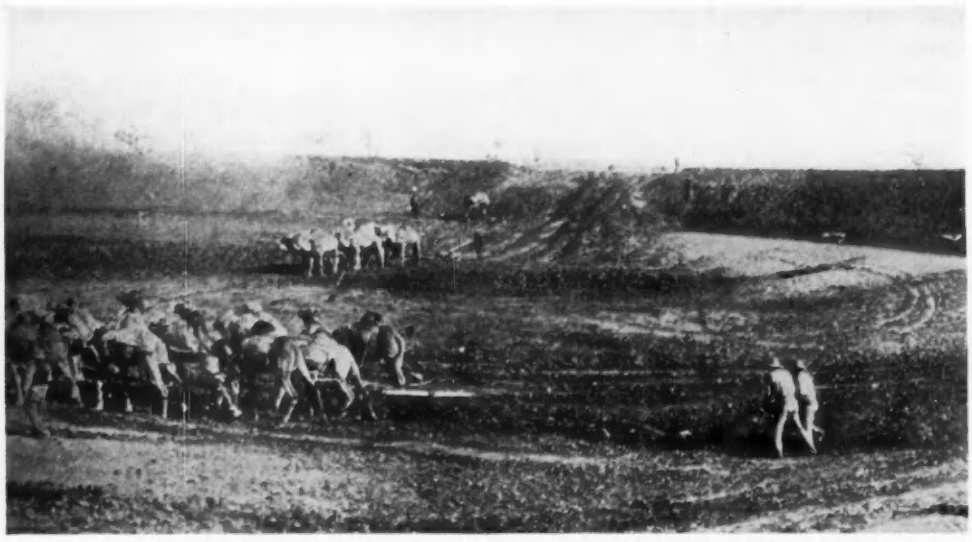

FIGURE 7.—A West Australia wheat landscape. Camels sometimes help till the soil. (Courtesy of *The Mid-Pacific*, May, 1930.)

wheat have increased materially in Yugoslavia during the last ten years; production was largest for the years 1928–1929 while the following two years, 1929–1930 and 1930–1931, have shown a smaller crop (89,000,000 bushels for the latter period) on an increased acreage, partly the result of adverse weather conditions. There was an unusually high yield, 22.1 bushels per acre, during the peak year of production. For the next two years the yields were 17.9 and 16.6 bushels per acre. All these yields are higher than the average for 1909–1910 to 1913–1914. In 1930–1931, 5,357,000 acres were in wheat, as compared with 3,982,000 acres in the period from 1909–1910 to 1913–1914 (*Yearbook of Agriculture*, 1931, U. S. Department of Agriculture, p. 590).

Coincident with larger production, exports have increased, much going via the Danube and some south to Saloniki and thence to northwest Europe.

The Yugoslav area producing surplus wheat is favorably situated for domestic and export shipments, and this doubtless will aid in gradually increasing wheat production.

Agriculture is yet largely of the hand-cultivation type. Owing to the small size of holdings, agricultural machinery will not be adopted rapidly. However, seed selection, fertilization, scientific rotation of fallow and crop, and similar modern agricultural practices may increase wheat production in Yugoslavia, and consequently its surplus for export; though here, also, raising of livestock is on the increase, as is wheat consumption.

Bulgaria

The potential wheat-producing areas in Bulgaria are somewhat smaller than before the boundaries of the country were changed. In exchange for some of the rich land of northeastern Bulgaria in the Dobrudja producing surplus wheat, mountainous country was obtained in what is now southern Bulgaria,

formerly the tobacco-raising land of Turkey.

The wheat lands of present-day Bulgaria are in the northern part, along the Danube; in the lowlands of the Maritsa, Kamčiya, and other rivers, and on the plateau in the vicinity of Sofia.

The area producing surplus wheat is that along the Danube, facing Rumanian wheat lands on the opposite shore. It is a fertile plain with deep, dark soil, something more than 16,000 square miles in extent. Geographically, it is part of the Rumanian and Russian wheat belt, and has the same climatic characteristics. Rainfall is about 25 inches annually, coming during the growing season, while the harvest period is comparatively dry and generally has plenty of sunshine. As in other sections of the same region, rainfall here varies from year to year, and droughts are likely to occur.

The land reform following the World War did not affect production in Bulgaria as much as in Rumania. There existed no great landed aristocracy in Bulgaria as in Rumania and Hungary; instead, the bulk of the land was in small holdings. Nearly 7,000,000 of the total 8,700,000 acres cultivated in 1908, were in holdings ranging in size from 5 to 49 acres, and nearly 500,000 acres were divided into plots of less than 5 acres in extent. More than 800,000 proprietors of land, 95 per cent of the total number, owned these holdings of less than 50 acres. The land reforms of 1921 designated 74 acres as an average limit to the area of plowland holdings, provided the land was worked by the proprietor himself and his family.

Cereal production in Bulgaria is the outgrowth of peasant agriculture and the cultivation of small holdings. Hand labor and the single-blade, one-man, and one-horse or two-horse plows are used in cultivating the fields. Wheat is broadcast, and the grain is reaped and threshed by hand. Machine agriculture is practised but little.

Cereals constitute the principal crop in Bulgaria, and occupy more than one-half the plow land. About half the cereal acreage is in wheat. Since the war this has expanded steadily, until in 1930–1931 it amounted to 2,958,000 acres and exceeded the pre-war average for the same territory. Yield also has increased steadily, and in 1930–1931 averaged about 20 bushels an acre. Production has done the same, and in 1930–1931 amounted to nearly 61,000,000 bushels (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agriculture, p. 590).

In spite of this steadily expanding production, wheat exports have declined, as compared both with those before the war and with those during the years immediately following the war. The population is increasing and probably will continue to increase, and will thus consume more of the domestic product for food. In addition, there is evidence that per capita wheat consumption is increasing. Furthermore, wheat now occupies the best land in the country, and there is relatively small opportunity for expansion in acreage. There is a tendency also to raise more livestock and to use more wheat for feed. Consequently, the outlook is for a declining rather than an expanding wheat export from Bulgaria.

CHINA

This discussion will relate to that portion of China sometimes known

as China Proper, which includes the administrative districts established in Inner Mongolia, and Manchuria, but excludes Tibet, Sinkiang (Chinese Turkestan), and Outer Mongolia.

For the most part it is a country of mountains and hills, among which are some comparatively level areas, such as the valleys of Shansi and Shensi, the Red Basin, and the Yunnan plateau. The north China plain or Great Plain, and the Yangtze Valley and delta comprise the most extensive lowland regions, which are, however, proportionately but a small part of all China. Topographic conditions thus restrict cultivable land and compel utilization in some places, such as the Red Basin and parts of south China of hillsides, which would be left uncropped in regions of less severe population pressure.

Except in Manchuria the country is densely populated, probably more than 400,000,000 people, or three times as many as in the United States, occupying an area two-thirds as large as this country. Agriculture is intensive and farm holdings are small. The average size in 13 localities in north and east central China is 2.52 hectares,[13] or 5.2 acres.

No census is available affording authoritative figures for the amount of land in farms, the area not in farms, and the area of uncropped arable land. Various estimates have been made, but they are for the most part unsatisfactory, so judgment must be based upon field studies made by such men as Paul O. Nyhus and J. Lossing Buck.

The former, as American Agricultural Commissioner, traveled extensively in China, observing land utilization and farm practice, and it is his judgment that there is little uncropped arable land outside of Manchuria. In some areas there are slopes and plateaus which the Chinese say are too poor to cultivate. Soil surveys have not been made; therefore the real quality of the soil is not known. The possibility of planting, perhaps under a somewhat different farm system, is uncertain. Throughout China, from Mongolia to Yunnan, in many areas every possibility is utilized to wrest from the land, under adverse physical conditions, even a meager food supply, so that in all probability population pressure and attendant conditions of incredibly meager standards of living and low wages have quite completely taken up the land capable of yielding a food supply.

Although wheat might be grown in practically all parts of China except along the humid southeast coast, it is an important crop only in the northern part of the country. It is estimated that China produces for local consumption about 800,000,000 bushels of wheat annually. In some places this is winter wheat, followed by summer crops such as millet, kaoliang, or buckwheat, or it may be succeeded by summer fallow.

The Chinese farm, small and intensively cultivated, depends primarily upon hand labor, though the short-bladed plow which breaks up the ground preparatory to planting may be drawn by a mule, a donkey, or a Mongolian pony.

Uncertain or almost insufficient rainfall characterizes a large part of the wheat-growing area in China, as indeed of all China except the humid southeast coast. The following statistics for highest and lowest rain-

[13] Buck, J. Lossing *Chinese Farm Economy*, 1930, p. 35.

fall in July are an illustration of this:*

Station	No. of Years of Record	Highest (Inches)	Lowest (Inches)
Harbin	23	14.27	2.41
Peiping	34	32.48	1.92
Hankow	45	20.98	0.22

* Etude sur la Pluie on China (1873–1925) par le P. E. Gherzi, S. J., II[e] Partie, Shanghai, 1929, pp. 29, 115, 139.

The region of Shansi, Shensi, Honan, Hupeh, and Kansu has for generations been subject to famine. Rainfall here averages less than 20 inches a year, but is uncertain in amount and in seasonal distribution, though the maximum is usually in July and August. Obviously this area is marginally dry, and no doubt in a country where population pressure was less severe would not be cultivated so extensively or peopled so densely. Throughout this area precipitation varies greatly from place to place in the same year, and from year to year for the same season. Under existing conditions of transportation this region, like many others in China, must be self-sufficing, and is compelled to rely upon the local food supply.

Much has been written about possible extension of cultivated land in Inner Mongolia, but the limited and uncertain rainfall, comparatively short growing season, and drying winds would seem to favor grazing rather than cultivated agriculture.

Manchuria is probably the only region in China where large areas of uncultivated land may be found, and these are largely in the northern part. It was estimated by the South Manchurian Railway that there were, in 1929, 32,516,000 acres of cropped land in Manchuria. Of this, 3,207,000 acres were in wheat with a yield of 14.9 bushels per acre.[14] The uncropped arable land is believed to be about double the present cropped area, or about 60,000,000 to 70,000,000 acres. Should the same ratio between wheat and other crops be maintained on this new land as on that in cultivation, there would be 6,000,000 to 7,000,000 acres in wheat. With the present yield this would give a crop of 91,000,000 to 109,000,000 bushels.

Whether this acreage would be in wheat is a question. Manchurian climate is particularly suited to soy beans and other crops from which vegetable oil is produced, and the abundant man power supplies hand labor needed for their cultivation. If these crops are more profitable than wheat, the farmer in Manchuria may grow them and import wheat.

Wheat farming in Manchuria is, with only a few exceptions, on small-scale holdings, averaging from 2½ to 12 acres.[14] Horse power is supplied by the Mongolian ponies, but simple equipment and hand labor are the rule. Some harvesters and tractors have been purchased by railroads and large land owners, but practically all the agricultural implements sold in China are small, such as the single-blade, one-man, one or two animal plow. In all Manchuria there are today probably not more than 200 tractors, according to A. Bland Calder, American Commercial Attache at Shanghai.

Granting that the Manchurian wheat crop may be increased, it is by no means certain that it would be exported. Eventually roads and railroads will be extended in China, so that the Manchurian surplus may be shipped elsewhere within the country, and wheat-consuming regions of deficient food supply or crop failure may absorb the crop. Today lack of

[14] Nyhus, Paul O.: *Cropping Systems and Regional Agriculture in China*, p. 31, 34 (Mimeographed report).

means of transportation and communication prevents this, and millions may be starving as near as 700 miles from Manchuria, when surplus food supplies such as wheat, beans, or kaoliang are lying along the railroads of Manchuria and at the ports, virtually unsalable from world depression or other causes.

Thus, on the whole, the weight of evidence would seem at present to be against China's becoming an important exporter of wheat.

BRITISH INDIA

India is primarily a producer and consumer, rather than an exporter of wheat. In recent years population has expanded along with increasing wheat production. The average wheat crop in India ten years ago amounted to 352,000,000 bushels, and in 1930 it was 387,000,000 bushels, but exports were respectively 51,000,000 and 4,957,000 bushels (*Yearbook of Agriculture*, 1931, U. S. Department of Agriculture, pp. 591, 599). In 1921 the population was about 319,000,000, and by 1931 it was 352,000,000 (*U. S. Commerce Yearbook*, 1931, Vol. II, p. 519).

Wheat is grown in arid northwestern India from Bombay Province northward by irrigation, and as a dry-season crop in the middle Ganges Valley in the Central Provinces, and in Berar. Rainfall and humidity are too high to permit wheat production in the lower Ganges Valley, in Burmah, and on the rainy southern coasts.

In the United Provinces and the Punjab in 1928–1929 there were more than 17,000,000 acres sown to wheat, or about 70 per cent of the wheat acreage for all India, and more than half of this was grown under irrigation. Here, also, has been the principal expansion in wheat acreage for India.[15]

The government has already constructed large irrigation works in these provinces and plans for material extension of the irrigated areas. The Sutlej Valley project in the Punjab is planned to bring perennial irrigation to 2,000,000 acres, and the Lloyd Sukkur barrage, across the Indus below Sukkur, is expected to irrigate annually more than 5,000,000 acres in the Sind, and is the greatest work of its kind in the world. Other projects are contemplated which may provide irrigation for nearly 7,000,000 acres. Many more acres are believed to be capable of irrigation, either through control of stream flow or other methods of obtaining water. Opportunities for large expansion in irrigated acreage are confined principally to the Punjab and the Sind.

Small farms, averaging about 16 acres each, will continue to be the rule on the new irrigation projects, and only in exceptional cases, where several members of the family are cultivating them, will they be as large as 24 acres. Consequently, there will be individual small-scale agriculture, the single plow and hand labor, on both the new irrigation projects and the older cropped lands.

Irrigation will change production in parts of northwestern India from a precarious crop reaped once every few years to a sure crop each year. Thus regular and scientific cultivation, including use of fertilizers, can replace former haphazard methods growing out of the uncertainty of the crop. Fields will be green with crops and brown with harvests each year; in fact, the landscape itself will

[15] *Agricultural Statistics of India, 1928–1929*, Vol. I, Calcutta, 1931, pp. 5, 6.

be different, with cultivated fields in place of brown deserts.

In the six provinces of Bombay, United Provinces, Punjab, Bihar and Orissa, Central Provinces and Berar, and Northwest Frontier Province in 1928–1929 there were 24,654,000 acres of the total 24,925,000 acres of wheat in India. Essentially all the uncropped area of the country physically capable of wheat production is in the same provinces, where wheat represents about 10 per cent of the 228,000,000 acres sown.

Yields in India have averaged about 10 bushels an acre and, at this rate, 85,000,000 more bushels of wheat might be raised. Even though population should cease to keep pace with expansion in wheat acreage, probably a larger per capita consumption would absorb any additional crops. There is more likelihood that India may import wheat in the future than that it will be a large-scale exporter; although it may, in seasons of high price for wheat and small crops elsewhere, put considerable amounts of this grain onto the market, just as it has done in the past.

FIGURE 8.—An American tractor on wheat land in Wimmera, Australia.

The current fallow and cultivable waste other than fallow in the same provinces for the same year amounted to nearly 85,000,000 acres, and probably represent fairly well the area of uncultivated arable land. If all this land were cultivated and 10 per cent were in wheat, it would amount to 8,500,000 acres, some of which would, in the regular rotation, be in fallow. Should the ratio of wheat fallow to acres in wheat be the same as the 1928–1929 ratio of current fallow to net sown acreage, or 18 per cent of it, there would be about 6,900,000 acres in wheat. However, it would not be export wheat acreage, as such.[16]

AUSTRALIA

Wheat in Australia in 1910 and in 1920 covered little more than 6,000,000 acres.[17] In 1930–1931 the area in wheat was more than 18,000,000 acres, on which was produced a crop of 215,000,000 bushels (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agriculture, p. 591). When the Far East was cut off from its supplies of American wheat during the World War, Australian acreage

[16] Figures for net sown acreage, current fallow, cultivable waste other than fallow, and wheat acreage are taken from *Agricultural Statistics of India, 1928–1929*, Vol. I, London, 1931, pp. 4, 5, 6.

[17] *Official Yearbook of the Commonwealth of Australia*, No. 23, 1930, p. 477.

was expanded to provide grain for Japan and China. These countries have continued to import wheat from Australia as well as from Canada and the United States.

In recent years the largest increase in acreage has been in Western Australia, where low incomes from the sheep industry have favored a shift to wheat raising. However, the principal area of potential wheat land is in the eastern part of the continent, north and west of the present area of largest production, where climatic conditions are somewhat comparable to those in Texas and Oklahoma. At present the principal wheat acreage is in New South Wales.

Potential wheat land in Australia lies in semi-arid or sub-humid grassland areas, which, in most cases, have been pastured. These potential areas extend along the plains west of the mountains from Queensland southward, across Victoria to the ocean through a region of Mediterranean climate, and finally play out west of Spencer Gulf. Similar climatic conditions prevail in southwestern Australia in the vicinity of Perth, where, as in southern California, there is a transition zone inland to the desert. Thus the potential wheat lands of Australia lie in a great semi-arid crescent, broken only in the south where the desert meets the sea.

The Commonwealth Meteorologist has estimated that about 310,000,000 acres have a climate suitable for growing wheat.[18] From this must be eliminated mountainous or rough land not adapted to cultivation, the exact area of which is not known. Much of this arid margin is in or comparatively near the mountains, so possibly about one-third of it, or 100,000,000 acres, is level enough for cultivation. In 1930–1931, about 18,000,000 acres were in wheat (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agriculture, p. 591), which subtracted from the total would leave about 80,000,000 acres of uncropped potential wheat land, not all of which would be export wheat land.

Wheat, the most important crop in Australia, in 1928–1929 occupied 70 per cent of the crop land.[19] Probably the proportion of land in wheat may decrease somewhat with the growth of population, but, owing to the relatively limited area in Australia adapted to a somewhat dense population, the proportion of land in wheat may always be large, possibly about 50 per cent. There thus might be 40,000,000 acres of uncropped export wheat land, practically all of which is sub-humid or semi-arid, where fallow rotation is essential. Thus the actual potential area in export wheat in any one season might be about 20,000,000 acres.

The average yields of wheat per acre for Australia as a whole during the ten years 1919–1929 was 12.2 bushels;[19] because the uncropped land is of a marginal character both as to soil and climate, future yields may be less. If the yields were 10 bushels an acre, the uncropped land would produce 400,000,000 bushels.

These potential wheat areas are located favorably in relation to tidewater—few parts, if any, being more than 100 miles from an ocean port, and much of it nearer. Its location with reference to shipping routes to

[18] Taylor, Griffith: *Agricultural Regions of Australia*, Econ. Geog., 1930 (July), Vol. VI, p. 223.

[19] *Official Yearbook of the Commonwealth of Australia*, No. 23, 1930, pp. 476, 478.

wheat-consuming regions, however, is not so advantageous. The distance from Adelaide to Liverpool is 12,449 miles via Suez and 13,672 miles around the Cape of Good Hope; to Shanghai it is 6,600 miles, and to Yokohama nearly 6,300 miles.

Today more than half the Australian wheat exports of 82,000,000 bushels are divided about equally between the United Kingdom and British India. Of the other portion, Japan and Italy each take about 6,000,000 bushels, and China nearly 3,000,000 bushels.[20] Of these China, Japan, and Italy may increase their imports.

The industrial population of Japan is using more wheat in its diet. Within the last 30 years, per capita disappearance of wheat there has increased from 0.52 to 0.76 bushel, and the total disappearance of wheat within the country has advanced from 23,000,000 to more than 47,000,000 bushels.[21] A limited market for Australian wheat now exists in the Union of South Africa, also a wheat-raising country, and probably destined to be self-sufficing in wheat.

A larger market for Australian wheat may evolve in the densely peopled Netherland East Indies, which are nearer to Australia than to any other country with potentialities for producing large amounts of export wheat. Already the islanders have evinced a tendency toward a wheat diet. In tropical countries as a whole, wheat consumption averaged 46,000,000 bushels annually for the period 1909–1913, and 66,000,000 bushels for 1923–1927.[22] At the same time, average per capita consumption advanced from 11.24 to 12.67 pounds of flour, a 40 per cent increase in consumption, against one of 24 per cent in population.[23]

The domestic market in Australia will be circumscribed because the comparatively limited area of humid croppable land will tend to limit the growth of population, in so far as it is related to domestic food supply. The cropped land in 1928–1929 was only 1.1 per cent of the entire area of the country.[24]

AFRICA

The principal wheat-producing countries in Africa are in the north and the south. In Algeria, Tunisia, and Morocco wheat is a sub-humid crop, and in the Nile Valley of Egypt all of it is grown under irrigation. That of the Union of South Africa and southern Rhodesia is raised under humid conditions. Unirrigated wheat covers about 10,000,000 acres or 15,625 square miles, 80 per cent of which is in northern Africa, while that under irrigation in Egypt amounts to approximately 1,600,000 acres (*Yearbook of Agriculture*, 1931, U. S. Dept. of Agriculture, p. 591). In addition, some wheat is grown in eastern Africa.

There probably is potential uncultivated wheat area both in the northern and in the southern part of the continent between the present wheat lands and the desert, but, judging from meager soil, climatic, and topographic data, potentialities for wheat growing exist over wide expanses between the northern and

[20] *Australia, Overseas Trade*, Bull. 26, 1928–1929, p. 37.

[21] *The Wheat Outlook, 1930*, U. S. Department of Agriculture Misc. Pub. No. 95, p. 13.

[22] *The World Wheat Outlook, 1930*, U. S. Department of Agriculture Misc. Pub. No. 95, p. 13.

[23] *Growth of Wheat Consumption in Tropical Countries*, Wheat studies of the Food Research Institute, Stanford University, 1930, Vol. VI, No. 7, p. 348.

[24] *Official Yearbook of the Commonwealth of Australia*, No. 23, 1930, p. 474.

southern deserts and humid tropical Africa, and also along the high eastern tablelands of equatorial Africa.

Recorded facts of climate, soil, and topography are, however, for scattered regions, and are very limited. Consequently only very general estimates can be made by utilizing known facts and a few basic geographic principles. Topographic surveys are few and limited in extent. Soil surveys are even less numerous and less extensive, and climatic records are almost entirely for a short span of years, and for widely distributed places.

In addition to surveys and records for a few established centers, travelers and scientific expeditions have supplied some information. Of the latter, the observations made by H. L. Shantz on the Phelps-Stokes Expedition in 1925 are particularly valuable. He carefully observed and recorded the plant ecology of the region traversed. At the same time he collected soil sections which were brought back to the United States to be analyzed and studied by C. F. Marbut, Chief of the United States Soil Survey. Facts thus obtained were correlated with climate, soil, and native vegetation, and a very general scheme of possible soil distribution and land classification was worked out on the basis of known principles of soil science, as is shown in Shantz and Marbut's "Vegetation and Soils of Africa."

Because of the journeys in and writings about tropical and desert Africa, these aspects have been overemphasized. In reality there is much which may be properly termed temperate and humid land, for if placed on the Americas Africa would extend from Norfolk, Virginia, to Buenos Aires; and it corresponds to the latitude between Tokyo and Sydney, Australia, in the Orient.

Aridity covers the Sahara in the north, the Kalahari in the south, and the Somali coast in the east. Heavy rainfall comes to the Guinea Coast, Liberia, and the Gold Coast region; the heart of the Belgian Congo; and the Mozambique coast. Between these arid and humid regions are those of moderate precipitation, where warm temperatures prevail on the lowlands, and moderate temperatures on the highlands, as in East Africa and Rhodesia. These are the possible potential wheat-growing areas. To some extent, wheat is now grown—in Kenya, Tanganyika, and Rhodesia. Here, in general, soil and climate suggest wheat possibilities, but the effect on wheat of the high temperatures in these regions between rainy Africa and the deserts is unknown.

Irregularity in rainfall characterizes nearly all of Africa. Rainy and dry seasons alternate for most of the continent except on the deserts and the humid lowlands. Bordering the equatorial area are regions experiencing two rainy and two dry seasons annually, with drought conditions prevailing during the dry season. Along the northern coast and in the vicinity of Capetown rain comes during the winter or cool season, but most of southern Africa has a summer maximum.

Africa is, on the whole, a tableland surrounded by narrow coastal lowlands, except in French Equatorial Africa and in Libya, where lowlands extend well into the continent. With the exception of the lowlands just mentioned, the equatorial portion of the continent lies at an elevation of 1,000 to 5,000 feet, or more, thus producing the rather tem-

perate climate characteristic of tropical lowlands.

Sufficient data do not exist to construct climate and soil maps of Africa, but from the scattering records maps showing probable trends of rainfall and soil belts have been prepared by Kincer and Marbut, respectively, while Shantz has worked out similar maps for vegetation and land classification.

This material appears to be the most pertinent to use as a basis for estimating the potential unused wheat area of Africa, though obviously the figures thus arrived at are necessarily only suggestive, and subject to revision as more information becomes available from future field surveys, and as temperature and rainfall records accumulate for many places and for a long period of years. The estimates made are offered for consideration to stimulate constructive thought as to the agricultural possibilities of Africa, rather than to present facts founded on complete field data.

On his Land Classification Map, Shantz has divided Africa into various areas according to their agricultural potentiality, and has shown for what types of utilization each area is suited, and the degrees of potential productivity within each type.

FIGURE 9.—A Transvaal field. (Courtesy of M. Edward, Johannesburg.)

"To arrive at a conclusion as to the agricultural possibilities of an area it is necessary to know the character of its climate, its soils, and its natural vegetation. Natural vegetation presents a complete adjustment of plants to their environment, while soils, . . . closely reflect the climatic conditions under which they were formed. Both thus afford a valuable guide to the range of production of a given region. The land classification map is therefore based on the

vegetation map and the soil map. The soils are known only in very general terms, and the detailed portions of the land classification map are therefore based almost entirely on the vegetation map. Areas which coincide in outline on the vegetation map and the soil map were retained as units on the land classification map. Where the same type of vegetation is shown to extend over several types of soil, such, for example, as residual and alluvial lands which differ in suitability for crop production, this difference was shown on the land classification map. Broad soil and plant types were recognized in so far as possible. The land classification map is not merely the result of superimposing the soil and vegetation maps. Many of the areas which would be segregated in this way have been reunited in order to reduce the number of classes and make the distinctions of greater significance."[25]

Shantz further makes a synopsis of characteristics of each type of land, which presents, among other facts, his judgment as to their agricultural possibilities. All areas for which he named wheat as a possible crop were measured by planimeter on the land classification map.

Next a similar measurement was made for lands which Kincer mapped as receiving between 20 and 50 inches of rainfall. It is believed that under temperature conditions existing in Africa these probably would be respectively the lower and upper rainfall limits for wheat.

Probably wheat could never be an important crop on either the outer humid or arid margins of land to which possible wheat production was assigned, therefore these margins were eliminated and only the 20 to 50 inch rainfall area used. This amounts, in Africa, to roughly 3,000,000 square miles.

Within this region are rough, high, and rocky, and some swampy areas, the extent of which is unknown, but which, judging from general information, may comprise one-third or even one-half the area. Using the latter ratio would make the potential wheat-growing area 1,500,000 square miles, or 960,000,000 acres. Subtracting from this the humid wheat land now cultivated leaves about 1,480,000 square miles, or 950,000,000 acres, uncropped and capable of producing wheat.

So little is known of this land that the acreage capable of producing wheat of the type now largely demanded in export trade cannot be estimated, so the African area has not been added to the others in the summary table, presented in this paper.

If and when cultivated, other crops, such as millet, vegetables, and cotton, doubtless will be planted on this land. This is especially true in regions of relatively more dependable rainfall, good soil, and favorable topography, such as the uplands of eastern Africa, in the Rhodesias, portions of the Union of South Africa, and areas bordering rainy central Africa.

Should a sufficient local or export demand arise, wheat also may extend farther over the sub-humid or semi-arid lands of Algeria, Tunisia, and Morocco; those extending across the southern border of the Sahara; and areas skirting the Kalahari in the Union of South Africa.

Because of the lack of definite information no estimates are being made of possible export area, crop, or yield in Africa.

[25] Shantz, H. L., and Marbut, C. F. *Vegetation and Soils of Africa*, pp. 225–226.

IMPORTANCE OF PIPE LINE TRANSPORTATION

John K. Rose

MORE than one million miles of pipe line help to make United States great. The railroads of our country have less than one-fourth as much mileage as the pipe lines; moreover, pipes do almost as much transporting in terms of ton-miles as do the railroads. There is invested in the pipe line systems of the United States the enormous sum of nearly $10,000,000,000, approximately one-fortieth of our total national wealth.

TABLE 1
COMPARISON OF MAJOR FORMS OF AMERICAN TRANSPORTATION
(All figures are approximate)

Form of Transportation	*Length of System (Miles)*	*Ton-Miles Per Year*	*Valuation of System*
Railroads	250,000	500,000,000,000	$20,000,000,000
Motor vehicles (surfaced road)	600,000	34,000,000,000	12,000,000,000
Pipe lines	1,100,000	400,000,000,000	10,000,000,000
Electric railways	40,000	11,000,000,000	5,000,000,000
Airplane	34,000	33,000,000	200,000,000
Inland waterways	4,000	11,000,000,000	1,000,000,000

The present study is an attempt to make available such information as will result in pipe lines receiving increased attention at the hands of those interested in transportation.

The above table is a summary of transportation in the United States, showing at the same time the important place occupied by pipe lines.

This study rests on three chief bases. Information concerning city water mains, sewers, and gas mains has been sought by the questionnaire route. The replies received have been used as the basis for computations. Another part of the foundation upon which the present article rests is the rather specialized discussions found sparingly in the various oil and gas journals besides a brief mention in a few recent books. The third is a knowledge of general geographic principles and facts which has been applied to pipe line transportation.

LENGTH AND VALUE OF AMERICAN PIPE LINES, AND THE WORK THEY DO

Water Pipe Lines.—Replies were received recently to a questionnaire from thirty-two cities of over 100,000 population situated in nineteen well-

TABLE 2
WATER PIPE LINES IN THE UNITED STATES
(All figures are approximate)

Valuation (Original Cost)	*Distribution*	*Primary Main Miles*	*Secondary Main Miles*	*Total Miles*	*Load per Day in Gallons*	*Distance Average*	*Ton-Miles Per Year*
$1,040,000,000	Cities of 100,000 or more	65,000	47,000	112,000	4,866,000,000	15	107,000,000,000
434,000,000	Cities of 2,500 to 100,000	57,000	42,000	99,000	2,825,000,000	5	21,500,000,000
150,000,000	Los Angeles				185,000,000	24	67,500,000,000
300,000,000	New York City				928,500,000	33	15,000,000,000
						103	97,000,000,000
	Cities of 54,000,000 non-urban population (rough estimate)						20,000,000,000
	Movement of water in buildings and factories of cities (rough estimate)						30,000,000,000
	Total	122,000	89,000	211,000	8,804,500,000		358,000,000,000

FIGURE 1.—Level glacial plains like these represent the most favorable and cheapest conditions for laying pipe line. (Courtesy of The Buckeye Traction Ditcher Co.)

distributed states and the District of Columbia. From the information obtained, Table 2 has been computed.

Sewers.—Thirty-three well-distributed cities of over 100,000 population replied to the questionnaire on sewers. Table 3 is based on the data obtained from the questionnaire.

Drain Tile.—Some of the Corn Belt area of Illinois has as many as sixteen miles of tile drain per square mile. The corn belt of the United States contains approximately 235,000 square miles of land, of which about 140,000 square miles were in crop in 1925. If 100,000 square miles of this land were tile drained with an average of two miles of drain per square mile, there would be a total of 200,000 miles of tile drain for the corn belt alone. At an estimated value of $500 per mile, this corn belt drain tile would be valued at $100,000,000.

City Gas Mains.—Replies were received concerning their gas pipe lines from fifteen cities in twelve States. Those answering largely represent cities which did not reply in respect to water mains and sewers. Computations based on the fifteen cities check fairly well at various points with other partial sources of information on the subject (Table 4).

TABLE 3
SEWERS IN THE UNITED STATES
(All figures are approximate)

Location	*Main Sewers, Miles*	*Secondary Sewers, Miles*	*Total Miles*	*Load, Gallons per Day*	*Distance Average Miles*	*Ton-Miles Per Year*	*Valuation (Original Cost)*
Cities of 100,000	61,000	57,000	118,000	3,844,000,000	4.5	29,810,000,000	$1,548,000,000
Cities of 2,500 to 100,000	55,000	52,000	107,000	1,030,000,000	3	8,520,000,000	929,000,000
Drain tile estimated for Corn Belt alone			200,000				100,000,000
Total	116,000	109,000	425,000	4,874,000,000		38,330,000,000	$2,577,000,000

TABLE 4
CITY GAS MAINS IN THE UNITED STATES
(All figures are approximate)

Location	*Primary Main Miles*	*Secondary Main Miles*	*Total Miles*	*Load per Day Cubic Feet*	*Distance Average*	*Valuation (Original Cost)*
Cities of 100,000	83,000	81,000	164,000	1,210,000,000	5	$723,810,000
Cities of 2,500 to 100,000	75,000	73,000	148,000	544,000,000	3	434,000,000
Total	158,000	154,000	312,000	1,754,000,000		$1,157,810,000

FIGURE 2.—The combination of mountains and desert of southern California results in rapid temperature changes and consequent breaks in the pipe line system. (Courtesy of A. O. Smith Corp.)

The enormous volume of nearly a thousand billion cubic feet of gas is, however, so light that allowing an average of five miles for the distance transported, the ton-miles would remain below one billion. But because of the great value of the gas, the service of the pipe lines in transporting it is nevertheless highly significant.

Natural Gas Lines.—Besides the gas-distributing lines of cities just discussed, there are in the United States about 65,000 miles of natural gas trunk lines, approximately one-half in Pennsylvania, West Virginia, and Ohio; the remaining half is in or extends from mid-continental and California fields to markets even more remote. Until 1927, little was piped more than 300 miles, but now Chicago receives gas from Texas wells nearly 1,000 miles distant.

Natural gas production and consumption has increased rapidly. The 1930 consumption was nearly two trillion cubic feet of which approximately 80 per cent was consumed by industry and 20 per cent by domestic users. The total consumption value was nearly one-half billion dollars, and the investment in the industry, largely in transportation facilities, is approximately two billion dollars. The chief producing states are Oklahoma, Texas, California, and Louisiana. Fully one-fifth of the total production enters interstate movement of which the movement from West Virginia to Ohio is still quite important.

Nearly four times as much natural gas as manufactured gas is consumed. Of the natural gas total, about 44 per cent is used as fuel in the oil industry; manufacturing plants take about 20 per cent, carbon black plants over 10 per cent, and electric generation 5 per cent. At present the 20 per cent consumed domestically supplies at least part of the gas used by about five million consumers. Usually the natural gas is mixed with the leaner manufactured gas and distributed through the existing manufactured gas system of mains.

Of all phases of pipe line activity, with the possible exception of gaso-

line transportation by pipe line, the transmission of natural gas to remote industrial and domestic consumers is undergoing the most rapid changes. For the most part the gas lines, especially those in the areas of newer development, are large, even 26 inches in diameter. Pressures as high as 700 pounds to the square inch are used. Pumping stations costing as much as $1,000,000 each are installed. A single project involving $100,000,000 expenditure is nearing completion. Within the single state of Mississippi, gas lines valued at over $40,000,000 have been constructed during the last five years. The pipe line transportation of natural gas is a major development in the modern fuel economy of the nation.

TABLE 5
SUMMARY TABLE FOR NATURAL GAS, PETROLEUM, AND GASOLINE LINES
(Figures are approximate)

Type	*Miles*	*Load*	*Distance*	*Ton-Miles*	*Valuation*
Natural gas lines	65,000	5,500,000,000 cubic feet	150	Great vol. not weight	$2,000,000,000
Petroleum Lines	100,000	115,000,000 gallons	300	31,000,000,000	2,000,000,000
Gasoline lines (estimated)	3,000+				20,000,000

Crude Oil Pipe Lines.—Pipes used for transporting crude oil increased from a length of four miles in 1865 to 12,000 miles in 1914 and over 100,000 miles in 1930. In contrast to an eightfold increase in oil lines in the last sixteen years, railroads decreased in that period about 2,700 miles.

In general, these oil pipe lines are divided into trunk lines (usually 6 to 12 inches in diameter), and gathering lines of smaller diameter. These gathering lines operate by gravity or small pumps and are not usually permanently placed.

The trunk lines operate by pump under pressure of several hundred pounds to the square inch and are essentially permanent in location. The valuation of the system is placed at about $2,000,000,000, or nearly one-fifth of the total investment in the American petroleum industry. Almost all of the petroleum production of over one billion barrels a year is transported by pipe and some of it travels as much as 1,700 miles therein. Allowing that on the average it moves 300 miles in a pipe line, the ton-miles of transportation performed yearly would be approximately 31,000,000,000.

Gasoline Lines.—The newest pipe line activity is gasoline transportation. In the last three years the developments have been almost too rapid to follow. The Sun Oil Company now refines at Philadelphia and ships gasoline as far west as eastern Ohio. The Great Lakes Gasoline Pipe Line Company has a line which already carries gasoline from Barnsdall, Oklahoma, to Kansas City, Missouri. The line is being extended to St. Louis, Des Moines, Chicago, Milwaukee, and Minneapolis. The new Ajax line from the Cushing field of Oklahoma to the important refining center near St. Louis (Wood River, Illinois) is so constructed that one unit, or even the whole line, may be used for gasoline transportation. The Phillips Company plans a gasoline line from Borger, Texas, to St. Louis. The Standard Oil Company of New York plans a line from Providence, Rhode Island, to Worcester, Massachusetts. It would seem that in a short time gasoline lines will lead into the interior from several of the Gulf and Atlantic ports, as well as

from the Mid-Continental Field to the larger cities of the North Central States.

GEOGRAPHIC FACTORS AFFECTING PIPE LINES

The general geographic distribution of pipe lines; topography, the effects of hills and vales, swamps and streams; vegetation and tectonic forces, all of these are important influences. The soil environment plays a varied part. Usually soil is a beneficent blanket protecting the pipe against agencies of destruction such as changes of temperature; but sometimes instead of protecting, it destroys by corrosion. Climate with its vagaries of temperature; drouth; and flood affects profoundly the distribution, character, and life of pipe lines. The reciprocal effects between pipe line transportation is ever a menace, and the human geography of the country are already important, with certainty of increasing significance.

GENERAL DISTRIBUTION

While a supply of oil or natural gas result from favorable geologic conditions, geographic factors are important in exploitation. A water supply is, of course, directly dependent on the climatic factors which allow an accumulation of water, factors concerning not only the amount and kind of precipitation but also the amount of "run-off." Sewerage is related not only to the precipitation factor but also the factors which make possible the growth of modern cities.

Usually the demand or market for materials transported by pipe line will be found in areas of dense population, especially if urbanized. However, not only density of population but also the activities of the people determine the demand for water, oil, or gas. Industrial activity is especially significant. Petroleum, gas, and gasoline are largely used under conditions which make possible a power machine civilization, a high standard of living, and a dense population. The sewerage disposal areas are affected by water bodies and prevailing winds.

Thus water, gas, and sewer mains have a very wide distribution in our country, a distribution which correlates roughly with that of population. Perhaps three-fourths of the mileage of such mains are in the eastern half of the United States. Factors disturbing this correlation with population are precipitation, temperature, and the somewhat indefinite, but none the less real, influences which allow differences in urbanization and industrialization of the population.

Compared with the rather equitable distribution of mains of all types just discussed, the distribution of petroleum pipe lines is decidedly concentrated, being related to the important oil producing fields (Fig. 3). In some of the productive areas, especially in the Mid-Continental area of Oklahoma and Kansas as well as in smaller areas of Texas, Louisiana, California, and Pennsylvania, the concentration is intense, sometimes more than a mile of line per square mile of area. In the Los Angeles area, where lines commonly follow the public roadsides, there are sometimes as many as twelve closely crowded lines. In the producing areas, the lines, mostly of gathering line size, spread out in a tangled mat like the widespreading roots of a plant. From the maze, trunk lines lead to the Gulf Coast, the California Coast, or across country to the more

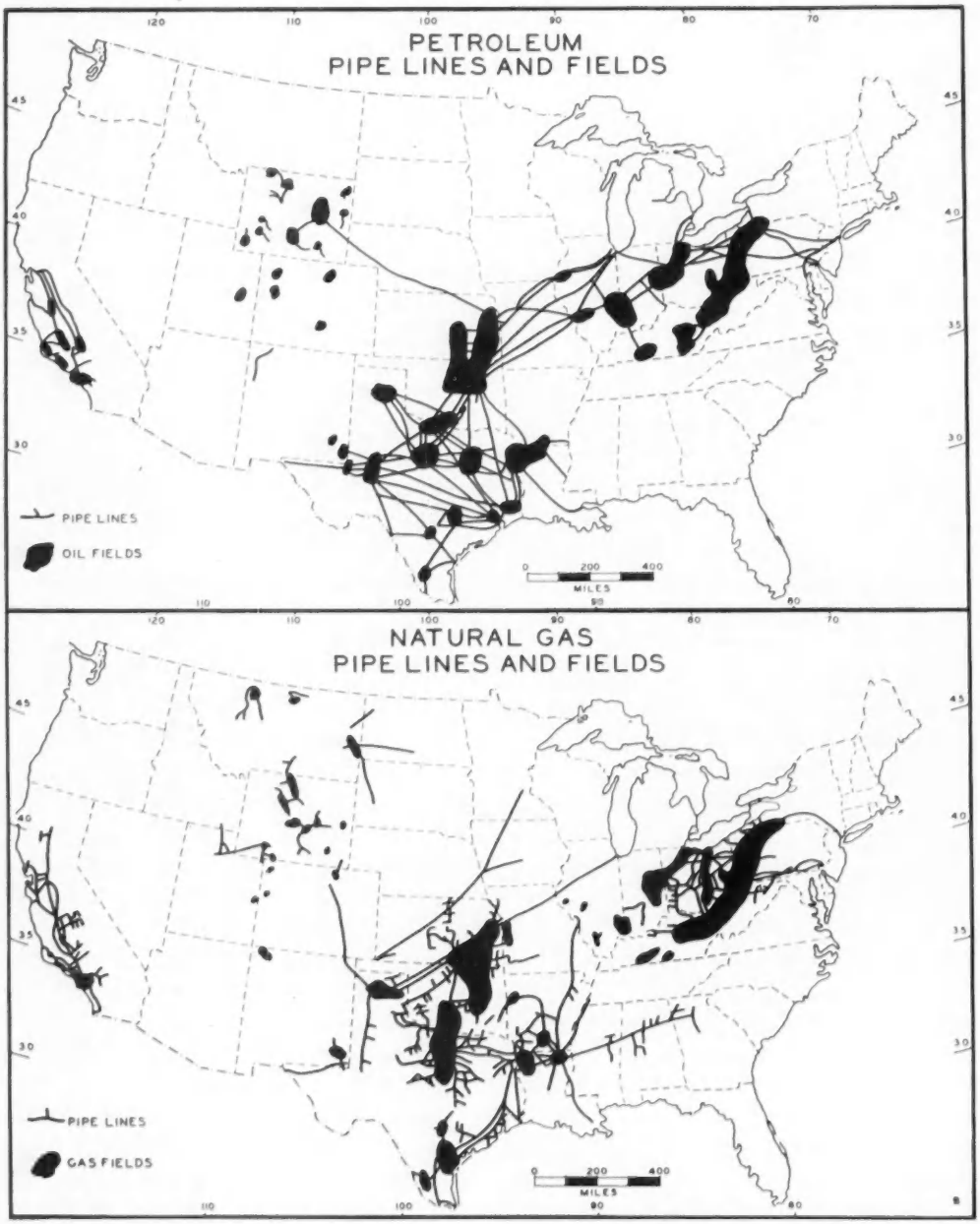

FIGURE 3.—A comparison of the natural gas producing areas and pipe line transmission with the petroleum producing areas and oil pipe line routes. The extent of these pipe line systems surpasses general imagination.

densely populated areas about Lake Michigan and thence on eastward to the Atlantic. Gathering lines rarely exist without trunk lines; but, as in Colorado and New Mexico, the product may either be refined locally or shipped by tank car. The large producing states, as Texas, Oklahoma, and California rank far in the lead as regards mileage of line. The distant end of the trunk line shows no such network as exists on the gathering

end. The market end is a refinery which, until recently, has not distributed its products by pipe.

Gasoline pipe lines, though rapidly developing, as yet form only a fragmentary system. Mainly they lead from refineries in the Mid-Continental area to the larger cities of the Eastern Interior. Other and shorter lines lead from eastern ports into the hinterland.

Although there are fewer miles of natural gas than of petroleum pipe line in the United States, the distribution is wider (Fig. 3). Long trunk lines appear not so commonly, and the network near the producing fields of Pennsylvania, West Virginia, Kansas, Oklahoma, Texas, Louisiana, and California is not so much an evidence of gathering lines as a network of market lines delivering the gas to industrial plants or for distribution through city systems, perhaps after mixing with manufactured gas.

Gas lines lead to towns, not around them as do petroleum lines, which lead only to the refinery. The blank areas in the gas line map, less conspicuous but in much the same parts of the country as lack petroleum lines, are being reduced in size by the rapidly extending gas mains which are bringing to more and more communities the great convenience of this superior fuel.

TOPOGRAPHY

Pipe line materials flow up hill only at the cost of much applied pressure. Valleys, ridges, and stream crossings are evils to be avoided if possible; the most satisfactory topographic condition is represented by well-drained plains of gentle relief, upon which it is possible to follow drainage divides and use machinery for most of the excavating. Hence, the pipe line route is selected with particular attention to topography, and of late an air survey of proposed routes has been used.

Sharp valleys and ridges must be smoothed off somewhat to keep the pipe, especially if a high pressure gas pipe, from uncovering itself under the inertia of its pulsating load. Consequently such country is avoided if possible. An example of this avoidance of hilly areas, is afforded by the Ozarks, around which go many pipe lines. Lines follow the Great Valley of California, but few cross the Coast Ranges to the Pacific Coast.

FIGURE 4.—A Dresser coupled gas line in the steep, rocky slopes of the Blue Ridge Mountains. (Courtesy of S. R. Dresser Co.)

Not only is the maintenance of the line more difficult because of steep slopes, but construction is greatly hindered. In ditching machinery is likely to be used with difficulty, if at all. For example, the Southern Line from Louisiana fields to Atlanta, Georgia, in crossing the state of

Mississippi passed through much country having five to ten rolls per mile—one ridge and one valley to the roll—and with about 75 feet difference in elevation between valley and crest. These alone, though not rocky made necessary a 50 per cent greater construction cost than would have been required over a gently rolling area. Between North River and Pell City, Alabama, where there were six to eight rolls per mile with the valleys as much as 200 feet deep, the slopes sometimes as great as forty-five degrees, and considerable rock present, the ditching cost four times the so-called normal.

Poorly drained land is also a disadvantage to construction and operation. Such areas are common on the Gulf Coast and to a lesser extent locally in river valleys and on glacial till plain. The greatest disadvantage comes in construction, for the area may be flooded most or all of the year but not deeply enough for barge construction. Ditching machinery of the ordinary type can scarcely be used and sometimes even the steam shovel is nearly useless. Oxen may be used to drag the pipe into position; sometimes even men do the work at greatly increased cost. On the Southern Gas Line a forty-mile swamp strip in western Alabama required about ten times the effort and time which would be required under ordinary conditions. In the swamps of Louisiana and the Yazoo Delta of Mississippi, many miles of large main are under water for months at a time during flood season. At such times the pulsating gas lifts the line except where ballasted with concrete, a rather expensive proposition.

If a stream is subject to torrential flood or to rapid changes in its banks, the problem of crossing is greatly increased. Most of the streams entering the lower Mississippi River from the west are more dangerous to crossing lines than the Mississippi River itself. The Atchafalaya River, which runs through alluvial deposits in central and southeastern Louisiana, is constantly slicing off sections of its banks. The first line across it in 1910 was lost. New lines with much slack to allow for creep are used. The Standard Oil Company's cross-

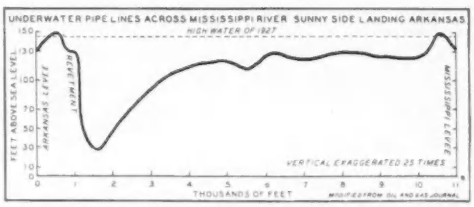

FIGURE 5.—The profile of the under water pipe lines across the Mississippi River at Sunny Side Landing, Arkansas, the vertical scale exaggerated twenty-five times.

ing of the Atchafalaya River at Melville, Louisiana, illustrates the vicissitudes experienced. Four of the six crossing lines were torn out and another put out of commission by a flood. A sixteen-acre tract upon which the station stood was covered with tons of fine sand to a depth of 15 feet. In spite of the fact that this is on a main artery of crude oil transportation from Oklahoma to Baton Rouge about four weeks were required for temporary repairs and about four months for complete rehabilitation.

Hence stream crossings are selected for permanency of banks and ease of approach as well as width and rapidity of water. Large streams are crossed by running the main line into a header box some distance back from the stream (Fig. 5). From this header box the gas or oil is brought out in several smaller pipes

FIGURE 6.—This quiet street has seen few events more interesting than this laying of pipe line by machinery. Comparatively easy construction conditions are in evidence. (Courtesy of Youngstown Sheet and Tube Co.)

which are spread apart to add a safety factor. If the stream has levees, these legally may not be cut or gone through but must be gone over, perhaps the pipe placed in concrete troughs over the levee. After crossing the levee the pipes will continue apart across the intervening space. This area is often swampy; sometimes quick-sand makes necessary the use of willow mats to keep the pipe from sinking before completed.

If the stream is large, the pipe is welded on barges and dropped into the river from pontoons. The pipe is always curved upstream to allow for slack under unusual conditions. If the stream is navigable, the pipe must be buried in the channel. The pipe used for river construction, besides being smaller, is usually heavier and often has river clamps weighing from 1,000 to 2,000 pounds fastened over each joint. This weight tends to bury the pipe in the bed. Sometimes such burial is accomplished by pumping the sand from around the pipe.

The Utah Pipe Line of Colorado, Wyoming, and Utah, though only 345 miles long, has twenty-six river crossings and sixty-five creek crossings. If the stream is small, lowering of the banks for approach is more likely to be necessary. Here too the pipe is usually buried in the bottom with a curve upstream. If the stream bed is of soft material, it will be trenched as in ordinary ditching. The pipe is taken across streams and even small rivers by welding on the bank and then dragging the line across. Sometimes crossings are made on bridges, especially where changes in altitude are abrupt and extreme.

Vegetation plays some part in the original location of the line in that the clearing involved in crossing timbered areas is costly. In addition, vegetation adds certain organic acids to soil water which increase the corrosion of the pipe. A grass or timber covering is helpful, however, insofar as it prevents rapid erosion by water or wind of the soil cover of the pipe line.

FIGURE 7.—Several smaller pipes instead of one large pipe are often used as a safety factor when crossing rivers. Notice the river clamps in place over joints of pipes and the curvature upstream to overcome the current. (Courtesy of Youngstown Sheet and Tube Co.)

Tectonic forces sometimes affect the operation of pipe lines. An example is the breaking of the pipes bringing San Francisco its water by the movement accompanying the severe earthquake of 1906. Now wooden pipes are often used in crossing major fault lines. Smaller shocks or jars of man-made origin may result in breaks; as of pipes crossing on railroad bridges, under railway tracks, or under city streets subject to heavy traffic. In respect to these latter possibilities, care is used to place the pipe near the edges of the street if possible. In going under railroad tracks the line pipe is often shielded with another pipe.

SOIL

There are several reasons for the practice of covering pipe line with a soil blanket. The pipe is thus placed out of the way of ordinary surface activities and escapes, at least in part, the pressure and jolts resulting from such activities as heavy traffic. Moreover, the blanket is a partial protection against diurnal and seasonal temperature changes.

If the soil mantle is thick, the ditching can usually be done, except in some marshy tracts, by efficient ditching machines. Bed rock near the surface means, on the other hand, slow and costly excavating work. Duluth, Minnesota, located on a stiff gabbro rock, reports the trenching to be eight times as costly as under so-called normal conditions. Parts of New York City, likewise, have igneous rock near the surface. This rock so greatly increases the cost of excavating that such tracts, including Central and Bronx Parks, were avoided when the city spread.

The Southern Gas Line from Louisiana to Georgia, already mentioned, which has 500 miles of 18 to 22-inch line and 400 miles of 12-inch line, required the excavation of 2,000,000 cubic feet of mud, earth, and rock.

The Utah Gas Line, 345 miles in length, required more than ninety stream crossings, one-half of which were in solid rock. One-tenth of the total mileage was excavated from solid rock. Sticky, mucky soils as are often found in parts of the Gulf Coast Plain may be almost as troublesome as rock in that ordinary ditching machinery is practically useless.

The chemical and physical character of the soil has important effects on the life of pipe. It is estimated that $75,000,000 were spent each year recently in treating pipe to lessen soil damage and to recondition damaged pipe. Physical damage seems to occur largely in clay soils. Electrolytic corrosion is not well understood, but also occurs largely in ill-drained clays.

Soils differ greatly within short distances in their corrosiveness. For some years past the Bureau of Standards has carried on tests comparing, under a variety of soil conditions, pipes coated with protective materials of several kinds. In recent years the major pipe line companies have carefully sampled and analyzed soil and subsoil along the routes selected and then provided the pipe with the best protection available against corrosive features of each type of soil encountered. Corrosion at Buttonwillow, California, proceeds at a rate twenty to thirty times as rapid as in soil regarded as non-corrosive. Coal cinders in cities or along railroads are also highly corrosive, and are avoided, or the pipe is carefully protected.

Soil conditions which result in the pipe having a non-permanent foundation may cause breaks. In West Texas the sand covering and foundation is sometimes removed by wind action, with resulting disaster. Peat soils, when drained, contract unevenly, thus injuring the foundation. New Orleans reports trouble with this latter condition.

CLIMATE

Minimum temperatures, extreme heat, cloudbursts, floods, and desert conditions all notably influence pipe line transportation.

Temperature

Low temperatures are ordinarily a decided handicap during pipe line construction. Freezing of the ground makes trenching and the subsequent backfilling more difficult. An extremely low temperature may, however, aid in crossing rivers. For example, the Prairie Pipe Line Company constructed its Mississippi river crossing at Fort Madison, Iowa, during January, 1930, when temperatures as low as -25 degrees F. had put thick ice on the river. The pipe was welded on the ice, tests made to locate leaks, the river clamps put on, enough slack provided, then the ice was cut with an ice plow, and the pipe lowered to the river bottom. This crossing on the ice required only one-sixth of the time ordinarily required for such a river crossing.

High temperatures, on the other hand, not only inconvenience the workers, especially the welders, but make necessary special provisions so that the line will not break when contracting under lower temperatures. This danger is averted by rippling, or the putting of an excess amount of pipe in the ditch. After being welded, it is left raised in places and sagging between. It is lowered into the ditch during the cool temperatures of the early morning.

The higher temperatures cause

minor difficulties in pipe line operation. In water pipes poorly protected from summer insolation, the water may become so warm as to be disagreeable for drinking purposes. Chemical corrosion of the pipe is also speeded up.

Low temperatures cause serious trouble. Figure 8 gives average and maximum freezing depths according to data recently made available by the United States Weather Bureau, and shows that in many cases city water mains are not located at sufficient depth to escape maximum frost.

Most petroleum, but especially that which has a heavy paraffin base, is quite viscous and must be rather warm, perhaps artificially heated, to make pipe line transportation practicable even under ordinary temperatures. Any lowering of temperature is likely to put the line out of commission by stoppages or at least to slow up greatly the rate of movement.

The variety of temperatures experienced in ranging from hot valleys to cold mountains is damaging. Breaks are especially common in the Tehachapi Mountains of California when heavy oil is being transported from the San Joaquin south to Los Angeles.

The heaviest demand for gas is when temperatures are lowest, the very time when, as explained by common physical laws, line pressure is naturally at its lowest due to the low temperatures.

FIGURE 8.—Average annual frost penetration (in inches), extreme frost penetration (in inches), and depth of cover of water mains in principal cities (in feet and inches) compared.

Rainfall

Excessive precipitation results in floods which damage pipe lines, especially at water crossings. An example of flood damage was given on page 198. Another illustration is that of some of the lines crossing at Wood River, Illinois, which were badly damaged during the flood of the spring of 1927.

Severe storms of all kinds stop construction work on pipe lines. Heavy rains, moreover, may cause caving of the open trenches, and may uncover completed sections on slopes. Sudden cloudbursts coupled with topographic and vegetative conditions favorable to rapid runoff, are almost certain to lead to trouble. Most areas, of course, experience thunderstorms but in few areas having pipe

lines are topography and vegetation so conducive to storm flood damage as the Colorado section of the western Great Plains. The Utah Gas Line, which starts in Northern Colorado, experiences a variation of over 3,000 feet in altitude. The main lines over streams in such areas are provided with check valves which localize the loss in case of breaks.

OTHER EFFECTS OF PIPE LINES

In addition to being strongly affected, as we have seen, by several geographic influences, pipe lines have become a part of the geographic environment, and in turn lead to various adjustments of significance to persons attempting to interpret present conditions, or to predict future developments. Their effects on the concentration of population, the distribution of wealth and of various activities of the people, and their effects upon other agencies of transportation especially merit consideration.

The transportation of water by pipe line has played a very important part in the growth of modern cities. As most sorts of manufacturing plants require much water, cities which have plenty of cheap water have a great advantage over cities with inadequate supplies. The present growth of the cities on the Great Lakes and larger rivers is increasingly due to the abundance, cheapness, and quality of the water available, rather than to transportation by water. Water service is a prime requisite to the development of any city addition.

Pipe line transportation of water has enabled Los Angeles, California, to strengthen the weak link of an otherwise splendid geographic environment, and thus become the most populous city of the West Coast. Moreover, Los Angeles owes its great areal extent directly to the fact that the only satisfactory source of abundant water is many miles away and all real estate developments needing water must come into the municipal corporation, in order to get enough water.

FIGURE 9.—Natural gas line through Louisiana swamp where among the moss-draped cypress and tupelo, malaria and other disease add to the physical difficulties. The line must be carefully protected from corrosion in the warm, acid waters. (Courtesy of Wailes Dove Hermiston Corp.)

The growth of such cities as Whiting, Indiana, is directly dependent on the pipe lines which bring the crude oil there for processing. Any change in pipe line activities to such areas almost certainly affects the development of the area. To a lesser extent the same is true of Gulf ports exporting crude oil brought there by pipe line. Some cities, as in Oklahoma, that early enjoyed a boom due to local refining which did not rest on a sound geographic basis, now find that the oil is taken by pipe line to more favored areas for refining.

The recent development in natural gas transportation illustrates how industries of the future may be located where other geographical factors are favorable rather than having to follow the fuel supply. No longer will the cities and towns near the discovered gas fields necessarily ex-

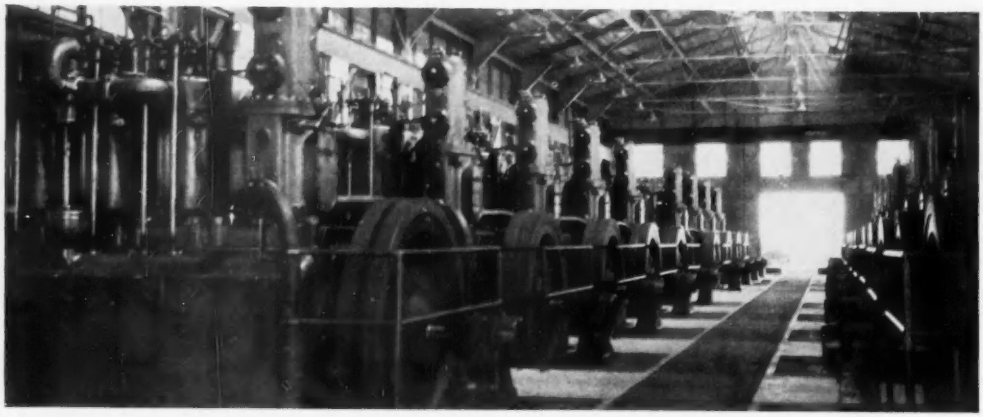

FIGURE 10.—Interior view of a gas compressor station. Great pumps keep the pressure even above 500 pounds per square inch in the lines, so that the supply flowing through the pipes keeps fairly even. (Courtesy of Hope Engineering Co.)

perience a boom as in the Indiana Gas Belt from 1880 to 1910. Instead, cheap long distance transportation by pipe line will allow the gas to be used largely by the industries of already well-established urban centers having other advantages than mere proximity to gas wells. Thus, pipe line transportation is one of the notable forces of the present civilization which tends to centralize that civilization by enabling the most favorable geographic environment to carry much the greater weight of the activities of civilization. Otherwise favorable environments are thus strengthened.

Moreover, pipe lines are affecting the geography of the country in that other forms of transportation are not now so much needed or used in certain areas as formerly. This has been a factor leading to the abandonment or lesser use of some railway lines. Furthermore, natural gas and petroleum, made widely available by pipe lines, is contributing to the abandonment of some marginal coal mines, even of some mining districts.

To summarize, it may again be noticed that the physical size, wealth invested in, and work performed by the pipe line system of the United States, is such as to allow basic comparisons with any other system of transportation. Several geographic factors, including topography, vegetation, soil, and climate, influence this system notably. This enormous system in turn has affected the other systems of transportation as well as influenced the growth of activities and of areas. Finally, it is one of the potent forces of the present and future in the centralizing of the activities of civilization in geographically favored regions.

CLASSIFICATIONS OF NORTH AMERICAN CLIMATES

A Review

Stephen B. Jones

GEOGRAPHY in general and geomorphology in particular stand in need of an accurate classification of climate. Such a classification must be based upon quantitative data. The most familiar classification of this sort is that of Köppen, but because his boundaries in North America do not coincide with the vegetative regions or with commonly-accepted climatic boundaries, American scientists have been led to attempt further quantitative classifications.

In Köppen's scheme all climates are distinguished with relation to moisture as either humid, steppe, or desert. The criteria for delimiting these different moisture types are selected values of the ratio of the annual precipitation to the mean annual temperature. Empiric constants are added to the temperature factor in order to take into account the effect of the different seasonal distributions of rainfall. The humid climates are divided into four temperature types. Steppe and desert climates are simply divided into "hot" and "cold." Empirically-selected temperature relationships are used as the limits of the temperature types. Regions are further divided upon the basis of rainfall régime.

Russell (3, 4) has endeavored to adapt Köppen's methods to the mapping of the climates of the western United States by means of refinements and redefinitions. He rejects Köppen's latest map (2) as inapplicable to the region and bases his work upon an earlier classification (1). He points out that the use of constants in adjusting the temperature factor for rainfall régime results in offsets in the boundaries of climatic provinces that must be smoothed out by interpolation. Russell adopts nine rainfall régimes in place of Köppen's three in order to reduce the offsets and the amount of interpolation. This refinement should be valuable in mapping small areas and mountainous regions. Russell adopts the January isotherm of 32 degrees Fahrenheit as his boundary between hot and cold climates, since this line fits the distribution of certain vegetative and topographical features within the western United States. Because the topography of this region is intricate and meteorological stations are widely spaced, Russell was obliged to use topographical maps and field observations of the distribution of both plants and land forms to supplement climatic data. Great credit is due him for the construction of detailed maps of the climates of California and of the dry climates of the western United States, but judgment as to the value of his methods awaits their application to a wider area.

In a recent publication (5) Russell presents the thesis that "a very distinct possibility exists that an occasional dry or desert year has greater significance in landscape than do the facts of normal climatic distribution." Dry and desert years are defined by

the same ratios of precipitation to temperature (with adjustments for rainfall régime) as were adopted for dry and desert climates, annual instead of normal values being used. Russell has constructed detailed maps showing the frequency of dry and desert years in the western United States during the period 1901–1920. He presents, also, graphic and verbal summaries of moisture conditions in each year of this period in the different parts of the region. In mapping variability of climate, Russell has made an important advance. Geographers interested in the distribution of land forms, vegetation, soils, and human occupancy in the western United States will no doubt test and extend the correlations that Russell suggests.

Van Royen (7) has attempted to adapt Köppen's methods to the climates of the United States and Canada east of the Rocky Mountains. Boundaries obtained by rigid adherence to Köppen's earlier definitions (1) are shifted to conform to vegetation boundaries. Van Royen points out that this departure from quantitative methods is due to the lack of good evaporation data. The isotherm of 50 degrees Fahrenheit for the coldest month is proposed as a criterion for separating hot from cold climates.

Thornthwaite (6) has made a more radical departure from Köppen's procedure. The data of precipitation and temperature are adjusted separately to secure figures which express the effectiveness of these factors in promoting plant growth. The seasonal distributions of "effective" precipitation and of "effective" temperature are then considered separately.

Thornthwaite assumes that evaporation is the principal factor reducing the effectiveness of precipitation in promoting plant growth. The areal boundaries of his five humidity types are defined by certain values of the precipitation-evaporation index. This index is the sum of the twelve monthly precipitation-evaporation ratios, multiplied by ten to eliminate decimals. The use of precipitation-evaporation ratios is not original with Thornthwaite. Earlier workers have, however, been handicapped by the fact that evaporation measurements are available for only a few stations. By using evaporation-pan measurements and precipitation and temperature data for a number of stations in the United States, Thornthwaite has evolved a method of calculating the precipitation-evaporation ratio from the monthly precipitation and the mean monthly temperature.[1] Thornthwaite's "precipitation-effectiveness" is at best only an approximation to the true amount of rainfall available for plant growth. This uncertainty appears to be unavoidable when evaporation-pan data are used, since these data are of low accuracy and may not agree even approximately with "natural" evaporation, which is a combination of soil evaporation, transpiration, evaporation from the surfaces of plants, and evaporation from bodies of standing and running water of a variety of sizes, exposures, and depths.

The boundary values of the hu-

[1] This method of calculation is not above criticism. It rests upon the assumption that a constant relationship exists between temperature and evaporation, and that variations due to the saturation deficit, the barometric pressure, and the wind velocity are negligible. The accuracy of the final formula—which involves a constant calculated to four decimal places and the exponent 10/9—is more apparent than real, since this formula is derived by the application of precise mathematics to approximate data.

midity types have been chosen at geometrical increments of the precipitation-evaporation index: 16, 32, 64, 128. Thornthwaite states that these values were chosen after field observation and the study of vegetation maps.

Thornthwaite recognizes four types of seasonal distribution of precipitation-effectiveness. The types are: "adequate at all seasons," "deficient in summer," "deficient in winter," and "deficient at all seasons." This use of "adequate" and "deficient" appears to be somewhat arbitrary. The rainfall of the Great Plains, for example, is classed as "deficient at all seasons," though obviously it is adequate for the native vegetation of the region.

The "temperature-efficiency index" is essentially the sum of the twelve mean monthly temperatures, adjusted to freezing point as zero. Temperatures below freezing are considered as of zero efficiency in promoting plant growth. For convenience, these figures are converted into an arbitrary scale giving a range of values the same as that obtained for the precipitation-evaporation index. The boundary values have been chosen at the same geometric increments as those of the humidity types. It is to be regretted that Thornthwaite does not discuss more fully his reasons for the choice of these and other boundary values.[2] The reviewer knows of no reason for assuming that the effect of temperature is the same as that of precipitation on plant growth or the distribution of plant associations.

Thornthwaite has classified seasonal distribution of temperature-efficiency on the basis of the relative amount of summer concentration. The addition of this fourth factor in climatic formulae seems to the reviewer to simplify rather than to complicate the classification of climate. Köppen has included seasonal distribution of temperature in some of his definitions, but he does not evaluate it as a separate term.

Thornthwaite, like Köppen, uses letter formulae to designate his climatic types, but his system is more elastic than Köppen's. Each of the four factors is represented by a separate letter, and any combination is possible, whereas some of Köppen's symbols combine both temperature and precipitation significance.

Examination of the colored map which accompanies Thornthwaite's article reveals that only three climatic factors have been used in its construction. Seasonal distribution of temperature-efficiency has been disregarded. The surprising and serious discrepancies that appear on the map are apparently due to the omission of this fourth term. Kodiak Island and the coast of the Gulf of Alaska are included in the same climatic province as the Yukon Valley and the northern forest of Canada. The Puget Sound lowland bears the same symbol as the Great Lakes region and New England. Palm Beach, Florida, is in the same climatic classification as Topeka, Kansas.[3] Inclusion of seasonal distribution of temperature in the construction of the map should eliminate these

[2] A minor criticism applies to the statement that the point of zero temperature efficiency is placed at the poleward limit of the tundra. No such place exists. Examination of the map shows that the edges of the Greenland and Ellesmere Land ice caps are the localities actually used. Permanent snow-cover, however, is as much dependent upon the amount of snowfall as upon temperature.

[3] In a world map of climates published privately by Thornthwaite, the classification of Florida climates has been rectified. The other errors remain.

errors by separating marine from continental climates. Although to include this fourth factor would make the map more complicated, it is necessary to do so if the map is to give the user a true picture of the climates of North America.

The addition of this fourth term by no means exhausts the number of the climatic factors affecting plant growth, or the distribution of plant associations, soils, or land forms. Geomorphologists are interested in the intensity or violence of rainfall, but whether it is practicable to include more than four factors in the construction of a map is doubtful.

Köppen's classification, except for the initial assumptions that precipitation, temperature, and rainfall régime are fundamental, is based on an essentially empirical procedure. He chooses (and adjusts, if necessary) values of the climatic elements that give boundaries approximating the observed distributions of plant associations and drainage patterns. This empirical approach may be defended upon the ground that the quantitative relationships of climatic data to plant growth and to the development of land forms are imperfectly understood. The method is subjective, in that the botanical or geomorphological features chosen as a basis depend upon the opinion of the observer as to their relative significance. It seems probable that the empirical and subjective nature of Köppen's classification is the reason that it has failed to give entirely satisfactory results when applied to North America. Thornthwaite's treatment of precipitation and temperature data is less empirical than Köppen's, but his choice of boundary values remains subjective, and, in some cases, arbitrary. Thornthwaite's classification is a stimulating departure from traditional procedure and seems, on the whole, to be more logical than Köppen's.

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BOOK REVIEWS

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Monthly Summary of Foreign Commerce of the United States, Parts I and II, December, 1931. Part I, 10 cents; Part II, 5 cents.

Part I gives the statistics of exports and imports by commodities, and also by principal countries. Part II gives statistics for exports and imports of commodities, economic classes, net customs receipts by months, method of carriage, custom districts, countries, commerce with noncontiguous territories, etc.

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Mineral Resources of the United States 1930 (Summary). Price, 20 cents.

This statistical analysis of the quantity and value of mineral products for the calendar year 1930 summarizes the principal results obtained from the annual canvass of the mineral industries by the United States Bureau of Mines. This report is essentially a summary of the complete volumes of individual reports on the mining developments in areas throughout the United States producing gold, silver, copper, lead, and zinc.

Asphalt and Related Bitumens in 1930. By A. H. Redfield. II:15. Price, 10 cents.

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MILDRED R. BASHORE

FENNEMAN, NEVIN M. *Physiography of Western United States.* 534 pp., maps and illustrations. McGraw-Hill Book Company, Inc., New York.

A few years before the close of the last century, J. W. Powell outlined the physiographic regions of the United States. That original and masterly piece of work had a notable influence upon the development of the science of physiography in this country and later throughout the world. Many of the principles of physiography had been well established by eminent scientists, both American and European, and refinements were being made in our understanding of the work of rivers, glaciers, winds, waves, and all other agents that modify the surface features of the earth. The application of those principles to the study of the sequence of events in the physiographic history of a region marked a new era in the development of physiography as a science.

Nevin M. Fenneman, who has now produced a notable contribution to the literature on the physiography of the western part of the United States, and announced his plans to publish a companion volume on the eastern part, is one of those in the professional group of geologists and physiographers who have keenly appreciated the value of defining carefully the boundaries of the physiographic provinces and sub-provinces of our

national domain. He has appreciated also the value of summarizing our present knowledge of the physiography of each region thus defined.

Some years ago, as chairman of the Committee of the Association of American Geographers, Doctor Fenneman issued a map of the United States on which the physiographic regions originally defined by Powell were somewhat revised in the light of more recent studies. His accompanying text briefly described the physiography of each region. In the present volume he has completed a much larger task and done a masterly piece of work in reviewing all the literature pertaining to the physiography of the western part of the United States. He has presented in clear and very readable form a summary of our knowledge about each region under consideration. He has most generously given credit to all those who have done the original field work, so that the volume reflects the scholarly care which he has put into his own task. He gives the reader a full list of references to the original source material, so that more exhaustive reading may be done by any who choose to do so.

The western United States is interpreted to include everything west of the Central Lowlands. The first province treated is the Great Plains. From that study the reader is led on into the Rocky Mountain region, which is subdivided into the Southern Rockies, the Wyoming Basin, the Middle Rockies, and the Northern Rockies. The succeeding chapters deal with the great Intermontane Plateaus, with the Columbia Plateau at the north and the Colorado Plateau at the south, and the intervening area known as the Basin and Range Province. The closing chapters present the physiography of the Sierra-Cascade Province and the Pacific border regions.

The volume is wonderfully well illustrated. The relief maps, prepared by Guy-Harold Smith, are exceedingly useful in helping the reader to locate the several ranges and other pronounced physiographic features that are referred to in the text. Many structure sections and well-chosen photographic illustrations have been reproduced throughout the book. In the pocket at the back of the volume a map of the United States carries the latest revision of the lines defining the physiographic provinces and sub-provinces, with a key characterizing in a remarkably clear way, and in few words, the topography of each. The map itself is a notable contribution to all those who are interested in this field of study.

The Physiography of Western United States has no competition in the field of advanced regional studies in physiography. It should serve as the text to guide all advanced students in work on the physiography of the United States. Undoubtedly it will stand as the leading work of reference for more than a decade, and it may not be possible to improve upon it for two or three decades. Doctor Fenneman has made a great contribution to physiographic literature, and the companion volume, in which he will treat the physiography of the eastern part of the United States, is anxiously awaited.

The development of the principles of physiography has been very well done. The definition of physiographic regions has now been worked out for many parts of the world. The recognition of the fundamental importance of the physiographic regions in all studies of geography has been demonstrated over and over again. The regional treatment of geography is no longer a strange idea; it has been adapted to the teaching of geography in elementary form and in advanced studies of the science. It is essential in guiding research work in physiography, or in any other phase of geographical field work.

There remains, however, a remarkable fascinating field of investigation, which will naturally occur to the reader of Fenneman's book. What are the relationships of these regions to each other? While a peneplain was being developed in the Rocky Mountains, what was going on in the Colorado Plateau region, and in the Great Plains province? While the San Juan Mountains were being buried under extensive flows of lava, what was happening in the Front Ranges of Colorado, or in the Uintas, or in the Sierra Nevadas? The physiographer is always trying to unravel a story of physical evolution, to give in an orderly way an interpretation of the events which have led to the development of the present relief features of the earth's surface. Our next great field of investigation seems to lie in the correlation of regional studies in physiography. In that field there are just as fascinating prospects for those interested in the great outdoor world and in the great forces in the physical universe as were offered to the early masters of the science of physiography.

WALLACE W. ATWOOD

JOHNSON, DOUGLAS. *Stream Sculpture on the Atlantic Slope.* 142 pp., illustrations. Columbia University Press, New York, 1931. $3.00.

Seldom in scientific literature does one find complicated physiographic problems presented in a clearer fashion than in this volume by Professor Johnson. The material has been well organized and logically treated. Every sentence has been carefully worded. As an indication of the excellent manner and thoroughness with which the subject has been handled, it should be mentioned that the first five chapters of the volume were awarded the A. Cressey Morrison Prize in Natural Science for 1930 by the New York Academy of Sciences.

The volume is divided into three parts: the first dealing with the theory of regional superposition, the second with considerations favorable to the theory, and the third with implications of the theory. In the first part careful study is given to previous theories of Appalachian history. No stone is left unturned. Each hypothesis is faith-

fully presented, and the authors given full and generous acknowledgment. Following this treatment, Professor Johnson outlines his own theory of regional superposition. Nine excellent drawings help explain the sequence of events from pre-Cretaceous time through to the present.

The second part of the volume deals with the alignment of water gaps and wind gaps, the apparent great extent of the Fall Zone Peneplane, the degree of stream adjustment, and several other important considerations which favor the theory of regional superposition of streams from a coastal plain resting on a peneplane of pre-Schooley date. In connection with certain of the studies, especially in the New England section, Professor Johnson has used groups of projected profiles to assist in working out the relation of different peneplane surfaces.

In the third section attention is directed to certain far-reaching implications of the theory of regional superposition. Professor Johnson has not been content that his hypothesis explain only those facts it was invented to explain. He has gone farther and demonstrated that many features of the present Appalachian landscape are resultants of regional superposition. He has, furthermore, offered for consideration several new interpretations of the drainage evolution of eastern Pennsylvania and northern New Jersey.

To many readers Professor Johnson's new book will be a source of valuable material for course work on physiography, while to others it will be a fascinating drama of earth history. Those who read carefully cannot fail to learn something of the long story of continental evolution. Clear descriptions and well-planned drawings make it possible for the reader to reënact in his own imagination the drama which has been going on in the Appalachian region for countless thousands of years.

Scene 1. (The Appalachian region in pre-Cretaceous time.) The stage is set, the curtain is slowly drawn. We find ourselves gazing upon a landscape of ridges and valleys. There are many swiftly flowing streams. The underlying rock formations are folded, with the axes of the folds oriented in a general northeast-southwest direction. Scene 2. (The Fall Zone Peneplane.) The ridges and valleys are gone, the country is monotonously flat, traversed only by a few meandering streams. In the distance to the east is the Atlantic Ocean. Scene 3. (The Cretaceous Sea.) The area for one hundred to two hundred miles inland is covered by a shallow westerly extension of the Atlantic. Scene 4. (The uplifted coastal plain sediments.) The sea has withdrawn, and youthful southeasterly flowing streams have established their courses across the raised ocean bottom. The streams are not flowing on the Fall Zone Peneplane which existed prior to submergence, but instead traverse a series of sediments which were laid down in the ocean. The gentle seaward slope of these formations has determined the southeasterly course of the streams. Scene 5. (The Schooley Peneplane.) Many thousand of years have elapsed. Youthful streams have become old. The ocean sediments have been cut away from almost all the area as far east as the present Fall Line, and the underlying rocks have been partially worn away to produce another great peneplane known as the Schooley. Scene 6. (Post-Schooley erosion.) The old southeasterly flowing streams have been intrenched, cutting deeply into the folded structures. Scene 7. (Harrisburg time.) The former Schooley peneplane has been greatly dissected, and the areas of less resistant rocks between the parallel ridges have been peneplaned. Scene 8. (Somerville time.) During the interval uplift of the land has occurred, and erosion has produced still another peneplane in the valleys between the ridges. The southeasterly flowing streams have become more deeply intrenched producing water gaps wherever crossing the resistent ridges. Once more the curtain draws. Scene 9. (The present.) The scene opens and we are looking out across the present landscape of the Appalachian Mountains. The Somerville peneplane has been partially dissected. There is a confusion of peneplane remnants. Streams have partially adjusted their courses to the rock structure. Wind gaps have been produced due to frequent cases of piracy. In spite of these many changes, however, the landscape still retains numerous vestiges of its ancestral surfaces. Chief among these are the southeasterly flowing streams superposed upon the Appalachian structure following the invasion of the Cretaceous Sea.

This, in brief, is the story of stream development in the Appalachian region so clearly analyzed by Professor Johnson.

WALLACE W. ATWOOD, JR.

LEITH, C. K. *World Minerals and World Politics.* xii and 213 pp., index. Whittlesey House, McGraw-Hill Book Company, Inc., New York, 1931.

VOSKUIL, WALTER H. *Minerals in Modern Industry,* ix and 350 pp., index and xiv tables. John Wiley and Sons, Inc., New York, 1930. $3.75.

Oil Conservation and Fuel Oil Supply. xiv and 165 pp., maps, charts, tables, and appendix. National Industrial Conference Board, Inc., New York, 1930. $2.50.

Modern civilization is increasingly dependent upon the material aspects of the environment; so much so that national development and international affairs are vitally related to the basic resources of coal, oil, iron, and copper, as well as to factors of soil and climate. These three books approach this significant fact from different aspects.

In *World Minerals and World Politics,* Doctor

Leith has written a factual study of minerals in their political and international relations, in terms which give the layman a graphic picture of the place which mineral resources play in world affairs.

The book by Professor Voskuil, *Minerals in Modern Industry*, is a comprehensive survey of the distribution and utilization of all the more important mineral resources.

Oil Conservation and Fuel Oil Supply presents a detailed study of the present status of the petroleum industry as it relates to supplies of fuel oil and gasoline.

The requirements of industry are now so diverse that the trade in minerals can no longer be localized. About thirty mineral districts supply over three-fourths of the world's mineral products. On account of this localization, international trade is inevitable, and the attempts to control the exchange of raw materials by tariff barriers is unwise. The routes followed by most minerals in their international flow converge in the North Atlantic, thus giving this basin a supremacy in political affairs. The industrial growth of Western Europe and Eastern North America during the past century has not been alone a matter of superior enterprise of their peoples, but a response to unusually favorable environmental conditions which afford most of the necessary raw materials. There is little promise of similar industrial growth elsewhere because of the fundamental deficiency in raw materials.

While most mineral substances are found in some amount in almost every continent, the demand for many minerals is on such a large scale that only the relatively few large deposits are economically suitable for exploitation. In this respect the United States is particularly fortunate because of our great reserves of coal, oil, iron, copper, and sulphur. No nation, however, is entirely self-supporting and even we are forced to depend upon others for our nickel, tin, asbestos, antimony, and tungsten; and are already drawing upon South America for iron ore, copper, and petroleum.

Doctor Leith contends that the energy output is the truest measure of national wealth and on this standard he compares the relative positions of the countries of the world. In the case of petroleum, the United States has produced more oil during the last eight years than in all preceding time. Taking the world as a whole, more mineral products have been extracted from the ground during the present century than since the beginning of mining. This process cannot continue indefinitely, and the time must eventually come when the mineral wealth of the world will be greatly reduced. It does not appear that substitutes will ever quite replace these exhausted mineral products, so that one of the pressing problems of our time is the wise utilization and conservation of those deposits which are more limited.

GEORGE R. CRESSEY

WILLIAMS, HENRY SMITH. *The Biography of Mother Earth.* 315 pp., illustrations, index. National Travel Club. New York, 1931.

Mother Earth is old. Her first birthdays have been forgotten, even by whatever rocks of the present may have witnessed them. The six days of creation and the few thousand years of her history have long been stretched into billions, almost to infinity, as far as the lay mind is concerned; and theories and histories by dozens have fought ignorance and prejudice for the right to be considered the true interpretation of the facts men find today. The tortoise supported by four elephants gradually gave way to a spinning globe. Laplace's fiery ball became a solid mass of planetesimals. The wrinkles of a shrinking skin are now blocks of sial afloat in sima. On and about these floating continents life evolved to man, leaving no record except a bone here and there, a footprint in the mud, a layer of crushed shells, or the vague outline of an algal form. These twos and twos man puts together, sometimes getting five, but gradually piecing out his life story—and Mother Earth's biography.

Henry Smith Williams' *Biography of Mother Earth* is another attempt to narrate Mother Earth's history and bring it logically to the climax of certain anomalous facts that have bothered more scientists than one. His Introduction raises a number of questions asked by the man in the street or the child in school who may wonder for a moment about the *why* of his world instead of just the *what*. His answer runs to 300 pages. He states again some of the problems of animal distribution still not satisfactorily explained; and he offers his Geoid-Balance Hypothesis to account for them. If Mother Earth approves his explanation—and this is a point of which Doctor Williams is particularly proud—she can signify her approbation within a very short time in answer to a few simple tests. If she does not—but, while her biographer makes no claim to infallibility, he thinks she does.

Footnote references, explicit quotations, much reference to authority—the reader who is accustomed to these earmarks on a scientific treatise will miss them. He who must have the results of learning and research presented with obscure solemnity must needs call this a fairy tale. Mother Earth's biographers are too often inclined to be formal and solemn in their accounts of her history, since what concerns Mother Earth is science, and science deals solemnly with scientific facts. Hence, few stories of her life as a whole have reached the general public, and perhaps never has a new interpretation been put before it in such an attractive and understandable form. It is unorthodox, to say the least, to present a new "Theory of the World" disguised as a popular biography, but the author assures us that his guesses have a proper background of hard facts and that he has previously set forth his hypothesis in one of those obscure documents with many footnotes that we like to think are

the truly scientific. He even suggests several simple tests for proving it, "the acid test, from which it will emerge either as a valid Theory or as a dreamland fantasy." To quote a paragraph from the Preface:

"But I hope also that no one will suppose that I put forward this new interpretation of the history of our planet in mood *altogether* whimsical. I present the hypothesis of Antarctic origin of the continents, and the concomitant thesis that the struggle for Geoid-Spheroid balance is the motivating impulse back of continental migrations, as a comprehensive 'Theory of the World,'—to adopt an antique but expressive term—which attempts to correlate a wide range of geological and biological data that have hitherto seemed very far from synchronization."

His whimsicalities lighten serious reading for the uninitiated, and often a jocular remark will drive home a point that might have been lost among tongue-twisting scientific terms. But his theme and general presentation are serious enough to hold the attention of the scientific reader, who, while he may not agree with all the author's interpretations, must admit that his story hangs together pretty well throughout its great length. An idea of the treatment, as well as the subject matter may be gained from a glance over some of the chapter headings:

BOOK I

The Archeozoic and Proterozoic Eras

CHAPTER

I. The First Continent
II. Then There Was Life
III. Primitive Populations
IV. Two Spinning Globes
V. The Continent Afloat
VI. That Billionth Birthday
VII. The First Argosy
VIII. Back in Gondwanaland

BOOK IV

The Tertiary Period

CHAPTER

XXIII. At the Parting of the Ways
XXIV. The Age of Eohippus
XXV. Head-On
XXVI. The Two Great Hungers
XXVII. Elephants from Africa
XXVIII. The Mating of Lemuria and Asia
XXIX. The Rise of the Primates

Doctor Williams' biography begins with an Earth of rock, water, and atmosphere, and nothing else. The rock is concentrated around the south pole in one continent, Gondwanaland, of which Antarctica is but a remnant. Here occurs the beginning of all life, a sort of raw Eden for a sort of Adam-and-Eve interpretation of the multitudinous complexities, both geological and biological, found on the Earth today; for according to this theory, everything—continents, islands, and the life upon them—traces back to Gondwanaland and that one time when the elements and the sun were in such perfect accord that a fragment of matter appeared which manifested unique properties. Later, as the "attempt to find equilibrium between the great primal powers of gravitation and inertia" resulted in the break-up of Gondwanaland, the peregrinating continents carried with them the descendants of that first invisible bit of living protoplasm; and the development of these descendants was largely determined by the climate in the thermal zones through which the continents (their habitats) passed. Thus, the tropical vegetation which produced the coal beds of Spitzbergen flourished not during a warm spell in the north polar regions but during the time when Spitzbergen passed through the equatorial zone. The pull of inertia on the spinning globe urges on the continents, and the separation of families by the ever widening gaps between the drifting fragments of ancient Gondwanaland accounts for similar evolutionary development in regions otherwise widely separated.

Doctor Williams carries along simultaneously the account of the geological changes and the story of developing life, a rather large order for one biography. Not only lack of space, however, but lack of scientific data, prevent his speaking with too much certainty of individual events. His descriptions, however dramatic, must be vague, for Mother Earth herself, in her great age, cannot remember the details.

The illustrations are delightfully, and appropriately, hazy. Precise and belabeled diagrams have no place among them. The drawings are intended for the general reader and serve their purpose excellently. A series of globes shows the wandering continents at various stages in their careers. Pen drawings of some of the men who developed the sciences of geology and palaeontology give a personal touch. The pictures of the animals, sketched reconstructed against a timely background, leave just the right impressions. In this group the artist has outdone himself on the inside front cover, where the Mesozoic world fairly writhes with Brontosaurus, Mosasaurus, Plesiosaurus, and all the rest of the extinct Saurus tribes.

Persons looking for controversial points will find them in some of the details the author includes in his "Biography," in his interpretation of others, or they may disagree with his whole thesis. But one cannot condemn a book for that. Doctor Williams has really done an excellent piece of work in making Mother Earth live for the public through all her three billion years or more. New theory or old, the story makes good reading.

PRISCILLA H. WEBSTER

Metropolitan Districts, Population and Area. Prepared under the direction of Clarence E. Batschelet, Geographer of the Census; Fifteenth Census of the United States: 1930.

Metropolitan districts have become a significant factor in American life. They contain 45 per cent of the population of the United States and 1.2 per cent of the area. Wherever there is a large center of population, smaller centers develop about it. Transportation, telephone service, wholesaling and retailing activities, highways, newspaper deliveries, club life, and many other social and economic activities in general are coextensive with the area.

Ninety-six metropolitan districts have been established in the present census. They are designated by the name of the central city or cities, and only those were selected which contain a population of 100,000 or more. The central city or cities have 50,000 or more inhabitants.

In extent and boundaries these districts are not the same as those for the trade regions surrounding the same population centers. An attempt was made to work out these trade areas, but so many variables entered in the criteria, that it was impossible to attain uniformity in delineation of all districts, thus eliminating any comparability between them. Therefore the definite statistical bases of amount and density of population were selected.

A metropolitan community consciousness has developed within these urban areas. The political boundaries of the central city or cities are, in a sense, artificial in so far as trade, industry, communication, and construction are concerned. Population is shifting, in general, outward from the central city to the suburbs. Factories, formerly centered along railroads or water frontage within the central city are now occupying sites beyond the area of congested population, often in the open country along a railroad, where land costs less than in the central city and where there is room for expansion.

Merchandising methods are being adapted to this new urban family of cities and towns. Systems of transportation and communication must be revised, and sundry adjustments made in former services and enterprises, at the same time that constructive plans are being made for the future.

Until the 1930 census was taken facts of population were not available for these metropolitan areas as a whole. The 1910 and 1920 censuses limited the area of a metropolitan district to that within 10 miles from the boundary of the central city, but the 1930 census did not apply this limit, and included within the metropolitan district, "in addition to the central city or cities, all adjacent and contiguous civil divisions having a density of not less than 150 inhabitants per square mile, and also, as a rule, those civil divisions of less density that are *directly* contiguous to the central cities, or are entirely or nearly surrounded by minor civil divisions that have the required density." Most districts extend into two or more counties, and some embrace area in two or even three states.

The racial, sex, and age distribution is given statistically for the central city or cities and all minor civil divisions within the metropolitan district, as well as distribution of the entire population within the area.

Maps, one for each metropolitan district, form an exceedingly valuable part of the report. They cover the metropolitan district and territory adjacent to it, presenting a break-up into minor civil divisions and showing towns throughout the region. The district itself appears in this setting and included within it are the larger and smaller component political units.

Probably no more significant contribution has been issued by the Census in recent years. The geographer, economist, and sociologist; the distributor, manufacturer, engineer, and many other business and research groups will utilize the information presented on the maps and in the text and statistical tables.

HELEN M. STRONG.

ECONOMIC GEOGRAPHY

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ECONOMIC GEOGRAPHY

Published Quarterly by

Clark University, at 10 Ferry Street, Concord, N. H.

Editorial Office, Clark University, Worcester, Massachusetts

PRICE, $1.50 THE CURRENT NUMBER

FIVE DOLLARS A YEAR
(except to charter subscribers)

Entered as second class matter at the Post Office at Concord, N. H., under the Act of March 3, 1879

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FINLAND

A LAND of such limited and monotonous resources as Finland must organize and regiment its economic and political affairs and activities most minutely and completely if its people are to compete successfully with more richly endowed lands of the earth and achieve a material and cultural standard of living in accord with the industrial and educational ideals and aspirations of a progressive civilization. This Finland has done, almost wholly in its post-war independence of its earlier connections with the imperial Russian domain.

A rich store of coniferous timber; abundance of water power; adequacy of transportation—chiefly by waterways; advantageous coast-line and frontage upon the seas; an ambitious, thrifty, forward-looking people, particularly along the sea-board; these are Finland's few resources. By utilizing them to the best advantage, by building her economic and political structure to safeguard the common weal without sacrificing the right, or depreciating the incentive, of the individual to express his personality, to acquire comfort and competence, to possess his own little bit of God-given soil and waterway, Finland has pushed forward to her proud position in the vanguard of civilization and progress.

Her standards of personal worth, private culture, and public service are perhaps as high as any in the world. Her educational system is excellent from the tiniest woodland school in Karelia to the superb University in Helsinki. Her transportation, her finances, her commerce, her industry are all rationally regulated. Her hygiene and sanitation, her health safeguards, and her home conveniences are under government supervision, without onerous infractions of personal liberty. Her farms are well tilled and managed; her forests are scientifically administered; her cities are models of urban convenience, cleanliness, and orderliness; her ports are efficiently operated. Helsinki is certainly one of the most modern, most capably governed, most effectively functioning cities in the world.

Finland with her dearth of resources and paucity of advantages, and with her high cultural standards of life, like all the Scandinavian countries, is a lesson to the world in efficient land utilization, organization of industry, administration of government, and promotion of national peace and prosperity.